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UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 417

Contribution from the Bureau of Entomology
L. O. HOWARD, Chief

Washington, D. C. PROFESSIONAL PAPER July 25, 1917

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THE GENUS CALOSOMA

INCLUDING STUDIES OF SEASONAL HISTORIES, HABITS, AND ECONOMIC IMPORTANCE OF AMERICAN SPECIES NORTH OF MEXICO AND OF SEVERAL INTRODUCED SPECIES

By

A. F. BURGESS, in Charge of Gipsy Moth and Brown-tail Moth Investigations, and C. W. COLLINS, Entomological Assistant

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By A. F. Burgess, *In Charge of Gipsy Moth and Brown-tail Moth Investigations*, and C. W. Collins, *Entomological Assistant*.

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INTRODUCTION.

In 1905 an appropriation was made by the State of Massachusetts for the purpose of bringing to this country parasites and other natural enemies of the gipsy moth and the brown-tail moth. During the same year Congress made a small appropriation to provide for an investigation of the European parasites of these insects and the work was taken up by Dr. L. O. Howard, chief of the Bureau of Entomology. As a result of a cooperative arrangement made between Mr. A. H. Kirkland, then superintendent of moth work for the State of Massachusetts, and the Bureau of Entomology, the general supervision and management of this work was placed in the hands of Dr. Howard and the appropriation by the State was made available for meeting a part of the expense of introducing, breeding, and disseminating such parasites as could be secured. This arrangement was continued after the moth work in Massachusetts was transferred to the State forester and the cost of importations, breeding work, and colonization of parasites from the gipsy moth laboratory, Melrose Highlands, Mass., was jointly financed by the Bureau of Entomology and the office of the State forester, conducted by Mr. F. W. Rane. Owing to the continued spread of the moths above mentioned, and the extension of the infested territory into other New England States, the problem became interstate in scope and since December 1, 1911, the entire work has been financed by the Bureau of Entomology.

A report has already been published by Dr. L. O. Howard and Mr. W. F. Fiske as Bulletin 91 of this bureau,[1] relative to the parasite work, and in Bulletin 101 of this bureau a detailed account is given of the satisfactory results secured from the introduction and establishment, in New England, of *Calosoma sycophanta* L., a predatory beetle imported from several European countries. Bulletin 251 of the United States Department of Agriculture, by A. F. Burgess and C. W. Collins, published in 1915, brings the data known about this predator up to that date.

In connection with the importation of this beetle and of several other species of Calosoma secured from Europe and Japan, it was found necessary to make a thorough study of the seasonal history of the different species concerned, in order that the work might be carried on in an intelligent way. Some time has also been devoted to investigating the seasonal history and habits of some of the native species of this genus, as well as to determining the reason why they have not proved as helpful in destroying lepidopterous larvæ as have the species imported from abroad. Many entomologists and curators of museums throughout the United States and Canada have sent full information concerning the various species of Calosoma in the collections in their charge, together with localities from which the specimens were secured. A considerable number have also forwarded beetles of this genus, and this has made possible an investigation of the habits of a considerable number of species that do not occur in New England. While it is impossible to mention individually all those who have so kindly assisted in this work by furnishing live specimens or data, the writers wish to extend their thanks for the help which has been so freely given. Special acknowledgments are due to Dr. L. O. Howard, who has encouraged the work which has been carried on in this direction and made helpful suggestions from time to time; to Mr. W. F. Fiske for his continued interest and hearty cooperation; to Mr. E. A. Schwarz for examining and determining material received from foreign collectors; to Mr. H. S. Barber and other assistants in the Bureau of Entomology at Washington, D. C., for collecting living material; to Dr. W. D. Hunter and the assistants in Southern Field Crop Insect Investigations of this bureau for similar collections; to Dr. W. M. Mann for the loan of his extensive collection of Calosoma; to Messrs. Kirkland, Rane, and many of the assistants engaged in gipsy moth and brown-tail moth work in Massachusetts, for cooperation and support in carrying on the work which has extended over a period of several years; and to Dr. Henry Skinner, of the Academy of Natural Sciences of Philadelphia, to Mr. Samuel Henshaw, curator of the Museum of Comparative Zoology, at Cambridge, Mass., and to Mr. Charles W. Johnson, curator of the Boston Society of Natural History, for the free consultation of the specimens in the collections of their institutions, as well as for many suggestions relative to the literature on this genus. Among the assistants at the gipsy moth parasite laboratory who have made possible the results which follow by carefully attending to certain phases of the work should be mentioned Messrs. S. S. Crossman, P. H. Timberlake, K. W. Brown, C. W. Stockwell, J. J. Culver, J. V. Schaffner, jr., E. A. Proctor, F. H. Mosher, J. N. Summers, J. E. Dudley, jr., and C. F. Hood. The photographs and illustrations have been prepared by Messrs. W. N. Dovener, H. S. Barber, and H. A. Preston.

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[1] Reprinted as House Document 977, 62d Congress, 3d session.

HISTORY OF THE GENUS CALOSOMA.

The oldest reference to any species of the present genus Calosoma that the writers have been able to trace is that of Réaumur,[1] published in 1736. The legends describing the illustrations merely refer to the species treated as a ''scarab,'' which was a very general term for beetles at that time. The account of the larvæ feeding in the nests of processionary caterpillars and the admirable illustrations of the larvæ, pupæ, and adults refer to the well-known *Carabus sycophanta* of Linnæus, although without mentioning the specific name of the insect. This reference was later cited by Linnæus [2] and subsequent writers, always in connection with *Carabus sycophanta*. The genus Carabus was described by Linnæus in 1758, or some time previous to that, as it appears in his tenth edition of ''Systema Naturæ.[2] In the list of species recorded appear *sycophanta* and *inquisitor* with many others that still remain in that genus. The following description of Carabus is taken from the foregoing publication.

> **Carabus.** Antennæ setaceae.
> Thorax obcordatus apice truncatus, marginatus.
> Elytra marginata.

Johann A. E. Goeze,[3] in 1777, referred to *sycophanta* as belonging to the genus Buprestis. A. F. de Fourcroy,[4] in 1785, also included this species in the genus Buprestis, giving a short description and notes on its habitat. Johann Guseb Voet[5] writes of *Carabus inquisitor* as *Buprestis sycophanta minor*, and later, in 1799, E. L. Geoffroy[6] includes both *sycophanta* and *inquisitor* in the genus Buprestis. These records are interesting in that they show how these particular two species of Carabus were transferred from their proper place to one of error and confusion. According to the present rules of nomenclature these species rightfully belonged to the genus

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[1] Réaumur. Mémoires pour servir à l'Histoire des Insectes, v. 2, 514 p., 40 pl. (p. 455, pl. 37, fig. 14-19). Paris, 1736.

[2] Linnæus, C. Systema Naturæ, ed. 10, t. 1, 826 p. (p. 413). Leipsic, 1758.

[3] Goeze, J. A. E. Entomologische Beyträge, t. 1, 736 p. (p. 687). Leipsic, 1777.

[4] Fourcroy, A. F. de. Entomologia Parisiensis sive Catalogus Insectorum quae in Agro Parisiensi reperiuntur. 544 p. (p. 42). Paris, 1785.

[5] Voet, J. G. Beschreibungen und Abbildungen, hartschaaligter Insekten, Coleoptera, Linn., von G. W. F. Panzer, 5 pt., 48 pl. 1793.

[6] Geoffroy, E. L. Histoire Abrégée des Insectes, t. 1, 556 p. (p. 144), 10 pl. Paris, 1799.

Carabus, in which they were included by Linnæus, until Friedrich Weber, in 1801,[1] subdivided the Linnæan genus Carabus into Carabus and Calosoma. The characters of the latter genus are presented verbatim below:

(Calosoma)*

Weberi.

E. Carabis Fabr. Linn.

Labrum breve, late emarginatum, corneum.
Palpi sex.
  Anteriores biarticulati, articulo primo longiore obconico, ultimo cylindrico, adhaerentes maxillae dorso.
  Medii longiores quadriarticulati, articulo primo brevissimo, reliquis obconicis, secundo longissimo, basi anteriorum adnati.
  Posteriores triarticulati, articulo primo brevissimo, secundo longissimo versus apicem paululum incrassato, tertio obconico breviore truncato, ligulae basi inserti.
Mandibula cornea, valida unidentata basi ciliata.
Maxilla cornea basi angulata, processu compresso uncinato, intus basi ciliato.
Labium transversum, corneum, late emarginatum, cum acuminae medio, lateribus rotundatis breviore.
Ligula membranacea, trilaciniata, lacinia media latiore ciliata.
Antennae filiformes, articulo primo valido, secundo brevissimo, tertio longissimo, reliquis obconicis, ultimo cylindrico acuto.
  Character habitualis.
Corpus scutellum, agile latum, alatum, subdepressum, marginatum, colore plerumque nitido.
Caput ovatum, exsertum, magnum, oculis lateralibus prominentibus globosis, antennis lateralibus ante oculos insertis.
Thorax planus, transversus lateribus rotundatis margine prominulo.
Elytra rigida subdeflexa, thorace latiora, longitudine abdominis.
Pedes cursorii, longi, femoribus subcylindricis, tibiis versus apicem paulo incrassatis, ante apicem spinosis, tarsis quinque articulatis.

* "*Sycophanta, inquisitor, alternans, reticulatus*, etc. huc referentur velim. Novem genericum deductum est a pulcher et corpus."

Weber evidently chose *sycophanta* for the type species of the new genus Calosoma either because it was the first species in the Linnæan list of Carabi to possess the foregoing characters or because it was the best known and most common of them. The writers have no good reason nor do they desire to adopt any other as the type for the genus in this paper. *Sycophanta* (Pl. I) has become common in many localities in eastern Massachusetts and southern New Hampshire and is becoming very well known by a large number of the inhabitants of New England and elsewhere. This species is considered the most valuable aid among the Calosomas as a destroyer of tree-feeding larvæ.

GENERAL SEASONAL HISTORY OF SPECIES OF THE GENUS CALOSOMA.

It was found that the various species of Calosoma, both foreign and native, with which experiments were made at the gipsy moth parasite laboratory have rather similar habits. Those which were reared in confinement and are considered in this paper ordinarily entered the earth and deposited their eggs either singly or in groups of from two to three. Propagating adults that are fed in jars containing 4 to 6 inches of earth usually descend to or near the bottom to perform this function. Infertile females which were denied males, frequently deposited large numbers of small eggs on the surface of the earth, seemingly not wishing to leave the surface and lose any possible chance of mating.

---

[1] Observationes Entomologicae. Continentes novorum quae condidit generum characteres, p. 20.

The eggs hatch in from 3 to 15 days, depending upon the temperature and season of the year, and to a slight extent upon the species. The longest time is required for those species that deposit many of their eggs late in May and during the first part of June. *C. calidum* Fab. and *C. reticulatum* Fab. emerge from hibernation early in the spring and the number of days spent in the egg stage is greater than with other species, *C. sycophanta* for example, whose normal period of reproduction is from June 10 to July 31. The period in the egg stage is much shorter as the season advances. The eggs of *C. sycophanta* often hatch in three days during very hot July weather.

After hatching, the young larvæ, which are white at first, rapidly grow darker in color. They remain in the location where the eggs were deposited until they reach their permanent color which varies from brown to black, and in from one to three hours begin to move toward the surface of the ground. When confined in jars, if food is not found readily, the more active specimens frequently feed on those that are weaker or less active.

In New England different species of Calosoma larvæ hatch from May 20 to August 15, and feed until mature upon various kinds of lepidopterous larvæ and pupæ. During this period they molt twice, the time in each stage averaging as follows: First stage 3 to 6 days, second stage 4 to 7 days, and third stage 9 to 15 days. When full-grown the larva burrows from 8 to 10 inches into the earth if it is rather soft, and if not, a shorter distance is travelled. From 4 to 7 days are required to prepare a cavity for pupation. The walls are made compact by the movements of the larva within the cell. After the larva has gradually contracted and has become shorter and thicker, the skin is cast and pupation takes place.

The pupa always lies in the cavity resting partly or wholly on the stiff hairs which are present on the dorsal side of the first five abdominal segments. From 10 to 15 days are ordinarily passed in this stage. The pupa is at first creamy-white, but the appendages soon begin to assume the color of the adult insect.

The adult issues during the latter half of July or in the month of August, and some species soon seek the surface of the ground and begin to search for food. *C. calidum* and *C. reticulatum* possess this habit. They feed late in the summer of the year in which they are larvæ and pupæ. Adults of *C. sycophanta*, *C. frigidum* Kirby, and other species remain in the pupal cavity until the following spring before emerging and taking food.

The longevity of the adults of different species apparently does not vary greatly, and under field conditions they undoubtedly survive three years or more. Adults of some of the species may live four years or more, and under conditions where species could be closely observed one female, *C. sycophanta*, has lived for more than four years. The reproduction of the adults in various years has a direct bearing on the age limit. If the beetles reproduce freely during the first and second years of their existence, they usually die at the end of that time.

NUMBER OF GENERATIONS OF CALOSOMA.

Strictly speaking, all the species of this genus thus far reared and studied have only one generation annually. A slight deviation from this rule was noted in the case of 2 males and 4 females of *C. scrutator* Fab. that were received from Onset, Mass., August 3, 1909. These beetles were placed in a Riley cage and given plenty of food at frequent intervals. On September 23 and 27, 23 small larvæ hatched from eggs deposited by one or more of the females. They were isolated and later fed inside the laboratory. Adults developed from some of these larvæ, November 9 to 12, and a few days later (November 16 and 19) were found on the earth in the jar searching for food. They fed until December 16, before entering hibernation.

This instance is cited to show that reproduction may take place in some cases very late in the season. Other females of the same species, confined at the laboratory that year, began ovipositing as early as June 14, which gave ample time for adults to develop before the middle of August. It is doubtful whether the adults of *C. scrutator* under field conditions in New England come to the surface of the earth for food as soon as they issue. The instance just cited indicates that they may do this in the southern United States.

FOOD HABITS OF ADULTS AND LARVÆ OF CALOSOMA.

The kind of food consumed by the adults and larvæ of the various species varies greatly under natural conditions. Of all the species with which experiments were made at the laboratory, everything offered in the way of lepidopterous larvæ and pupæ was eaten, and in some cases immature stages of Coleoptera and Diptera were attacked sparingly.

The caterpillars of *Porthetria dispar* L. and *Malacosoma americana* Fab. were fed more than other species because of their abundance in the field at the time needed (Pl. II, A). Caterpillars of *Euproctis chrysorrhœa* were abundant enough, even more so in some localities than the former species, but the ubiquitous and poisonous hairs of the caterpillars of the latter made their general use impracticable.

The beetles are ravenous for food at the time when the caterpillars of the foregoing species are in season and their larvæ feed voraciously upon either caterpillars or pupæ but usually destroy more of the latter. This is particularly true of the larvæ of *Calosoma sycophanta* in connection with *Porthetria dispar*. Many field observations have shown that the larvæ of the beetles are abundant at the precise time when caterpillars of this species are entering the pupal stage, and as much food is required for their development they are particularly adapted for destroyers of this pest. The same is true with the larvæ of *C. frigidum* in their feeding upon larvæ and pupæ of *Heterocampa guttivitta* Walk. These observations were published by Mr. W. F. Fiske[1] and the senior writer in 1910. On July 31 of that year Messrs. Fiske and Burgess found the adults of the beetle climbing trees and preying upon the caterpillars of the moth in Tamworth, N. H. On the same date 12 of the beetle larvæ were found in 1 square yard of leaf mold feeding upon the caterpillars that were congregating there for pupation. Further observations were made on August 21, which showed that as many as 80.2 per cent of the pupæ of *H. guttivitta* in one locality had been destroyed in the leaf mold by the larvæ of this beetle.

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[1] Fiske, W. F., and Burgess, A. F. The natural control of *Heterocampa guttivitta*. *In* Jour. Econ. Ent., v. 3, no. 5, p. 389–394, 1910.
Burgess, A. F. Notes on *Calosoma frigidum* Kirby, a native beneficial insect. *In* Jour. Econ. Ent., v. 3, no. 2, p. 217–222, 1910.

Both adults and larvæ of *C. calidum* Fab. search for their food on and near the ground. The species of cutworms which are often abundant during the spring and early summer furnish ideal food for this predacious insect and large numbers are destroyed annually.

Dr. A. W. Morrill has found that *C. peregrinator* Guér. in both the adult and larval stages is common as an enemy of the variegated cutworm (*Peridroma margaritosa* Haw.) in Arizona, and the late H. M. Russell of this bureau reported finding adults of *C. semilaeve* Lec. at Hollywood, Cal., April 7 and 27, 1911, feeding upon the larvæ of *Peridroma margaritosa* under pea vines. This indicates that the food habits of these two species of Calosoma are very similar to those of *C. calidum* in both the adult and larval stages.

Other data have been collected by various entomologists, and many observations were made at the laboratory at Melrose Highlands, Mass., most of which are given under the notes on each species and indicate that great benefit must result from the work of these inconspicuous friends.

ECONOMIC IMPORTANCE OF THE SPECIES OF CALOSOMA.

The economic importance of *Calosoma sycophanta* has been set forth in Bulletin 101 of the Bureau of Entomology by the senior author [1] and more recently by both authors [2] in Department Bulletin 251, but since the former publication was issued other interesting notes have accumulated and may well be added here. Dr. J. N. Summers of this bureau, during the early spring of 1912, began a careful study of the internal parasites of the brown-tail moth larvæ in a 4-acre sprout lot in South Lynnfield, Mass. In June it became necessary to discontinue the observations owing to the depletion by *C. sycophanta* of the larvæ and pupæ of the brown-tail moth. The Calosoma beetles had consumed in some cases from 50 to 75 per cent of the brown-tail moth pupæ per tree or, as was figured later, an average of 40 per cent for the whole area.

Mr. W. F. Fiske, recently of the Bureau of Entomology, while studying the gipsy moth and its parasites in Italy during the summer of 1911, was afforded an opportunity of observing the efficient control of the gipsy moth by *C. sycophanta* in a large forest. Mr. Fiske states that there were enough beetles in the forest at the time of his visit to consume all the gipsy-moth pupæ present, with the exception of those hanging from the trunks of trees or limbs which could not be reached by the predators.

The beneficial work which is being done by this species of Calosoma in New England through its feeding upon the gipsy moth and the brown-tail moth is now common knowledge in the section that has been longest infested by these pests.

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[1] Burgess, A. F. Calosoma sycophanta. U. S. Dept. Agr. Bur. Ent. Bul. 101, 94 p. (p. 48), 9 pl., 22 fig. 1911.

[2] Burgess, A. F., and Collins, C. W. The Calosoma Beetle (*Calosoma sycophanta*) in New England. U. S. Dept. Agr. Bul. 251, 40 p., 7 pl., 3 fig. 1915.

An outbreak of *Heterocampa guttivitta* in the White Mountain district of New Hampshire and parts of Maine began to attract attention in 1906 and 1907. The moths increased rapidly for several years and large areas of hardwood growth on the mountain sides were completely stripped. In 1909 this destruction reached its climax. *Calosoma frigidum* had by this year increased to such proportions that its effective work was everywhere evident in localities where these caterpillars had made their appearance. The junior writer had an opportunity of visiting several localities in North Conway, Intervale, and Tamworth, N. H., on August 20, 1910, when conditions were almost entirely relieved in so far as the ravages of the caterpillars upon the foliage were concerned. Examinations were made of many small areas of leaf mold where the moths had pupated in August, 1909, and it was found that an average of 87 per cent of the pupæ had been destroyed by the larvæ of *C. frigidum*, and that 3.7 per cent had died from the attack of parasites or from other causes. The remaining 9.3 per cent emerged during the spring of 1910, and the females deposited eggs that were immediately attacked by a small egg parasite, *Telenomus graptæ* How., which destroyed practically all of them. This shows the good work of *C. frigidum* coupled with the timely aid of parasites.[1]

A similar example of effective control to that of *C. frigidum* on *Heterocampa guttivitta* in New Hampshire was noted by Dr. J. B. Smith[2] in southern New Jersey a few years ago. This had to do with an outbreak of a geometrid caterpillar which covered the scrub oaks in enormous numbers. *Calosoma scrutator* and *C. wilcoxi* Lec. were also there in enormous numbers on the young oaks, feeding upon the geometrid caterpillars. Dr. Smith visited the locality the year following the outbreak but could not find a single specimen of beetles or caterpillars. This is an instance in which the beetles came in and made an entire clean-up of the lepidopterous pest, after which they evidently migrated to other sections and in all probability many died of starvation.

Calosoma calidum is quite common in localities where cutworms are doing great damage to crops. It is sometimes difficult to find adults of this species or their larvæ actually preying upon the worms, but the evidence of their presence in such an environment usually bespeaks their mission. Besides, as stated before, it is believed that *C. calidum* is more or less nocturnal in its food habits, which is much in its favor as an efficient enemy of cutworms. Numerous other accounts are on record concerning the beneficial work of the various species of Calosoma, although the previous records of some of the species are rather fragmentary.

LIMITS ON INCREASE OF SPECIES OF CALOSOMA.

Probably the most potent factor to be reckoned with when considering the increase of any species of Calosoma is the possible food supply. Second to this is the feeding and pupation habits of its lepidopterous host, for it is necessary that the caterpillars be feeding and pupating at the time when the adult beetles will reproduce.

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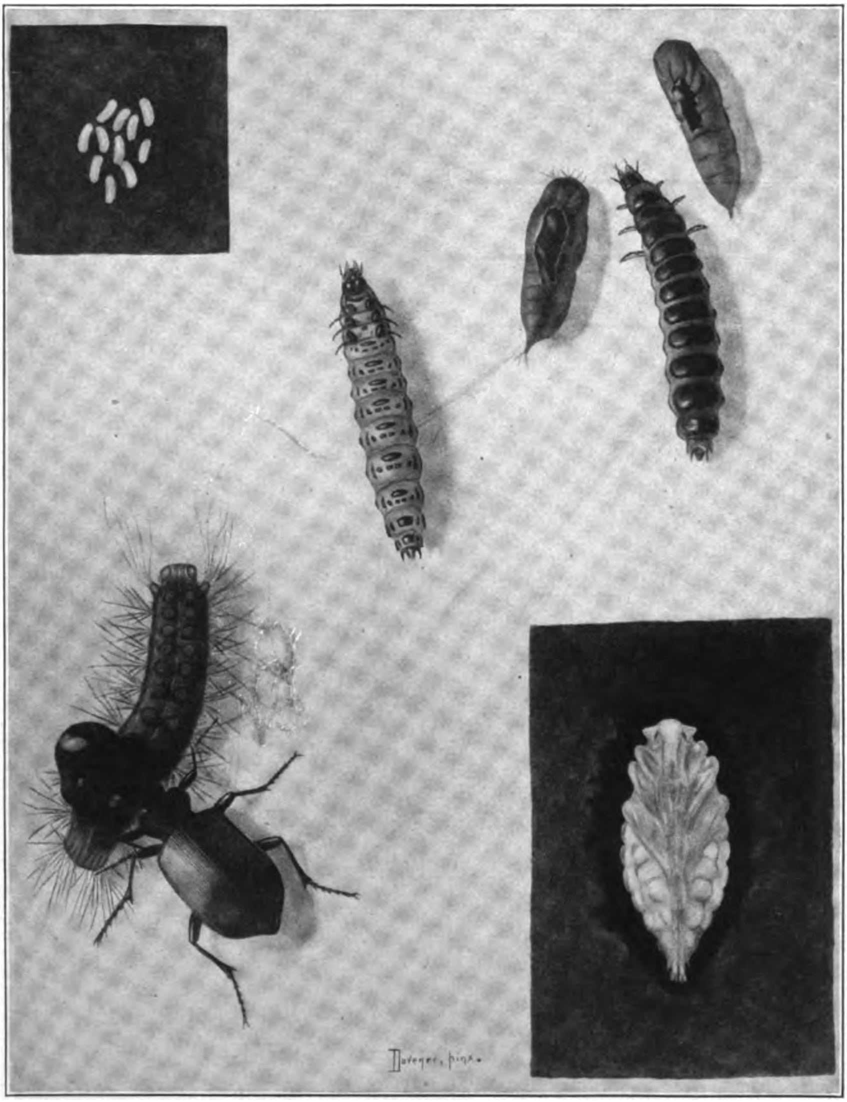
[1] The notes with others were published by Messrs. Burgess and Fiske in the Journal of Economic Entomology, Volume 3, Number 5, page 389, 1910.

[2] Smith, J. B. [Note.] *In* Ann. Ent. Soc. Amer., v. 4, p. 179, 1911.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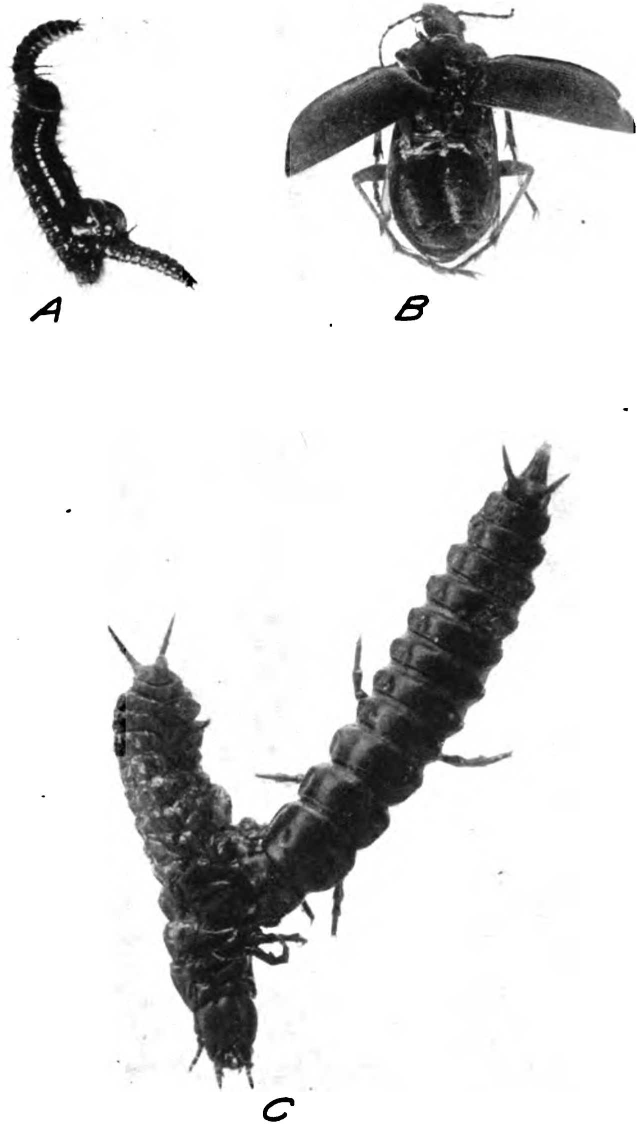
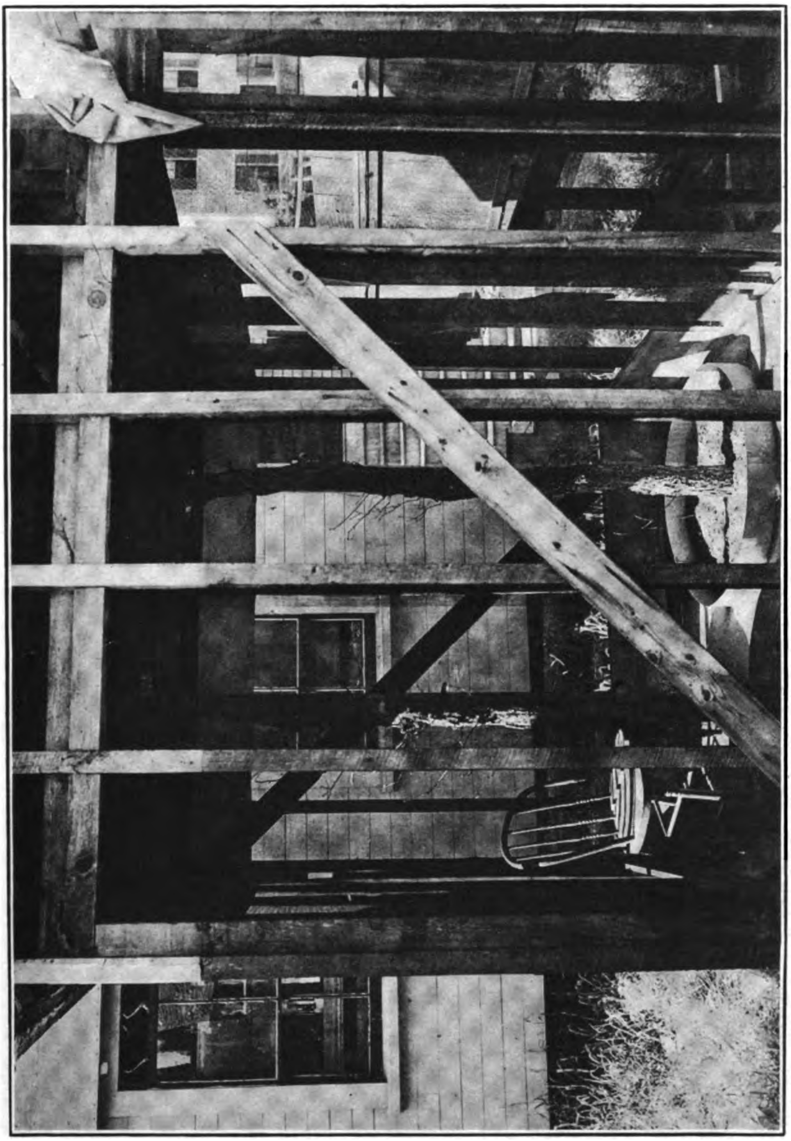
CALOSOMA SYCOPHANTA.

Adult Calosoma beetle eating gipsy moth caterpillar, lower left; pupa, lower right; eggs, upper left; eaten pupæ of gipsy moth, upper right; full-grown larvæ from above and below. All slightly reduced. (Howard and Fiske.)



CALOSOMA LARVÆ FEEDING, AND PARASITIZED BEETLE.

A.—**First-stage larvæ of *Calosoma sycophanta* feeding on larva of the American tent caterpillar (*Malacosoma americana*). *B*.—*Calosoma sycophanta*, showing puparia of parasitic fly *Biomyia georgiae* beneath wing covers. (Slightly enlarged.) *C*.—Larva of *Calosoma frigidum* feeding on another larva of the same species. (Original.)**



TREE-CLIMBING HABITS OF CALOSOMA LARVÆ AND BEETLES.

Outdoor shelter containing apparatus used in testing the climbing habits of Calosoma beetles and their larvæ. (Original.)

THE SKUNK AN ENEMY OF THE CALOSOMA BEETLES.

Excrement of skunk collected in the field showing many fragments of adults of *Calosoma sycophanta.* (Authors' illustration.)

For instance, if caterpillars and pupæ of *Malacosoma americana* and *Euproctis chrysorrhœa* were the only source of food for *C. sycophanta* in New England it is very probable that the beetles would increase very slowly if at all. The adults of Calosoma emerged from hibernation at Melrose Highlands, Mass., in 1910, between May 11 and June 28, the average date being June 2.[1] Usually a week or more intervenes before active egg deposition begins, and it is about June 15 before the eggs begin to hatch. The Calosoma larvæ that hatch from the first eggs deposited usually find ample food in the caterpillars and pupæ of *M. americana*, large, full-fed caterpillars of *E. chrysorrhœa*, and a little later the pupæ of this species. The supply of Malacosoma for food purposes is practically exhausted by June 25, and that of Euproctis by July 15. Between these dates the most active reproduction of *C. sycophanta* takes place under present conditions, and it is evident that the bulk of the larvæ would die from starvation if other food were not available. On the other hand, the habits of this beetle and its larvæ are so well adapted to those of the gipsy moth that it seems impossible for any other species of Calosoma to fare better on this particular prey.

Cannibalism among the larvæ of the various species is also no small factor in limiting the increase. All the species reared at the laboratory and further treated in this paper possess this habit in the larval stage. Irreparable losses have resulted in laboratory experiments when attempts were made to feed from 8 to 15 larvæ in a battery jar with 2 to 3 inches of moist earth in the bottom. As soon as the food supply was nearly exhausted the larvæ began to attack one another. (Pl. II, *C*.) Despite the large number of *sycophanta* larvæ reared for colonization work in New England, it was impracticable to feed many of them together for more than from four to six days after hatching, as the mortality in captivity became too high. After these larvæ reached the second stage the mortality rapidly increased from this cause. Cannibalism does not appear to be of special importance under field conditions unless the food supply is greatly restricted.

The ability of Calosoma larvæ to climb into the trees is an important factor. Many species are unable to do this and it is therefore impossible for them to feed upon arboreal lepidopterous larvæ. Species of Calosoma larvæ that are able to climb are thereby enabled to increase more rapidly and are of greater economic importance except in cases where the habits of the host are strictly terrestrial.

EXPERIMENT TO DETERMINE THE CLIMBING HABITS OF CALOSOMA LARVÆ.

A small white oak tree was cut during the spring of 1911 and two sections of it, each 6 feet 5 inches long and about 3½ inches in diameter, were set upright in a cage at the laboratory so that a study might be made of the climbing habits of the various species of Calosoma. The sections of the tree were held in place by wires attached near the top, and the base, which rested on the cement floor of the cage, was encircled by a strip of tin 4 inches high. This inclosure,

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[1] Burgess, A. F. Calosoma sycophanta. U. S. Dept. Agr. Bur. Ent. Bul. 101, 94 p. (p. 48), 9 pl., 22 fig. 1911.

3½ feet in diameter, prevented the larvæ from making their escape. A small amount of earth was placed in the circle. Later the size of the circle was reduced to 21 inches in diameter and it was found necessary to attach several partitions to the strip of tin, which extended nearly to the tree, in order to prevent the larvæ from traveling around the outer part of the inclosure (Pl. III).

A food cage, the bottom of which was made of ¼-inch mesh cellar-window screen and the sides and top of fly screen, was perched on the flat top of each section of the tree. The cage was made just large enough so that the bottom projected about one-half inch beyond the bark of the tree on all sides and the Calosoma larvæ had no difficulty in entering it if they were good climbers. *P. dispar* caterpillars or pupæ or both were placed in these cages, and the presence of the beetle larvæ could be easily determined by the injured specimens in the cages.

Tests were made with the larvæ of 11 species of Calosoma, namely: *Sycophanta* L., *scrutator* Fab., *calidum* Fab., *frigidum* Kirby, *lugubre* Lec., *externum* Say, *inquisitor* L., *reticulatum* Fab., *chinense* Kirby, *semilaeve* Lec., and *cancellatum* Esch. When possible the larvæ in each stage were used.

The results secured demonstrate that *sycophanta* is a natural climber in all larval stages; *reticulatum* larvæ climb considerably and with apparent ease; *chinense* climbs to some extent, but not so much as the preceding species. Larvæ of *scrutator* and *lugubre* are in about the same class, and seem able to climb to a small extent, but are very rarely inclined to do so. The larvæ of the remaining 6 species, *calidum, frigidum, externum, inquisitor, semilaeve,* and *cancellatum* show very little ability and no inclination to ascend trees.

Considerable information has been secured on the climbing habits of several species of adults and this is given under the species concerned.

NATURAL ENEMIES OF CALOSOMA.

It is undoubtedly true that beetles of this genus are destroyed in more or less numbers each year by natural enemies. The principal vertebrate enemies concerned are the toad, skunk, and various species of insectivorous birds. A considerable number become the prey of parasitic and predacious insects, although only a small amount of data is at hand to prove this assertion. Several cases are on record where adults of *C. calidum* have been found among the remains taken from the stomachs of toads, and Mr. F. H. Mosher, of the Bureau of Entomology, has observed these animals feeding on the species in the field. This observation was confirmed by an examination of the excrement, which contained small particles of the chitinous remains of this species.

On July 9, 1912, Mr. J. E. Dudley, jr., of the Bureau of Entomology, collected in Stoneham, Mass., a considerable amount of toad excrement in which parts of *C. calidum* could readily be determined.

During the summer of 1912 numerous observers reported that skunks were undoubtedly feeding upon specimens of *Calosoma sycophanta*. Most of these reports came from sections where this beetle was abundant and there seemed but little doubt as to the accuracy of the reports, although definite data were lacking. In order to secure more information on this subject a series of experiments was conducted by the junior author using captive skunks, foxes, and raccoons. The results of these experiments are given in a following paragraph and indicate that the skunk will feed freely upon these insects. Field observations in 1913 have confirmed the experimental results referred to above. In many sections of the territory infested by the gipsy moth where *C. sycophanta* has become abundant, unquestionable evidence was secured that skunks were destroying them in large numbers. In some cases it was possible to find the ground thoroughly uprooted over considerable areas, which indicated that these animals had been digging to secure beetles which were beneath the surface of the ground. In addition to this, large amounts of excrement were obtained, which showed that these beetles formed a large percentage of the food of the skunk. (Pl. IV.) In some cases it would appear that the work of this animal during the past year has been sufficient to retard seriously the increase of this beneficial species.

In June, 1912, a series of observations were made by Mr. Mosher in woodland near Melrose to determine whether birds were feeding upon Calosoma beetles. For some time previous it had been noted that along paths and wood roads a considerable number of wing-covers and parts of beetles were frequently seen. Although Mr. Mosher did not actually see birds feeding upon the beetles, he did observe many specimens of the towhee or chewink (*Pipilo erytrophthalmus*) in the woodland and saw one devouring a female specimen of *Prionus laticollis*. In the attempt to consume this insect the elytra were separated from the thorax and the eggs and internal tissues were eaten. As most of the hard parts of the insect were rejected, it is fair to assume that this bird may have attacked Calosoma beetles in the same manner.

The brown thrasher (*Toxostoma rufum*) has a somewhat similar feeding habit and may be considered a possible enemy of these beetles.

During the summer of 1913 observations were made by Mr. J. V. Schaffner, jr., and Mr. A. M. Wilcox, of the Bureau of Entomology, which indicate that the crow is an enemy of Calosoma adults. One of these birds was observed to seize a beetle and to convey it to its nest in a near-by tree. Several parts of beetles were found at the base of this tree and on examining the nest, which was occupied by young crows about 3 weeks old, five broken and torn beetles were found.

Among the insect enemies of Calosoma are the predacious bugs, although only a few records are available to support this conclusion. On July 7, 1910, Mr. Schaffner observed a nymph of *Podisus* sp. feeding upon a second-stage larva of *Calosoma sycophanta* at Brookline, Mass. During each season several different species of Podisus are found in Massachusetts, although they are not ordinarily abundant enough to destroy many insects.

In 1896 Mr. Burgess reared several tachinid flies from an adult of *Calosoma calidum*. These were determined by the late D. W. Coquillett as *Pseudatractocera calosomae* Coq., a species which he had reared some years previous from *C. peregrinator* Guér. in California. Since that time this species has been classified under the name *Biomyia georgiae* B. & B.

In 1912 several tachinid flies (Pl. II, *B*) were reared by the junior author from *C. sycophanta,* but the adults which emerged were so badly crippled that determination of the species was very difficult. The specimens have been examined by Mr. Frederick Knab, of the Bureau of Entomology, and also by Mr. Charles W. Johnson, of the Boston Society of Natural History. Their determinations agree that the species is either *Biomyia cinerea* Fall. or *B. georgiae.* Unfortunately there are no pinned specimens of *cinerea* with which the material reared could be compared, but owing to their poor condition and to the fact that these tachinids were reared from a Calosoma beetle collected in Massachusetts and not from one imported directly from Europe, it is probable that the species concerned is *georgiae.* Tachinid puparia have been found in the bodies of both *C. calidum* and *C. frigidum* during the last few years, and a careful comparison has failed to indicate any differences between these and the puparia of *georgiae.* Unfortunately, adults were not secured from these puparia. Mr. Johnson believes that this species should be more correctly referred to the genus *Vivania* Rond., so that rather positive evidence is at hand that *Vivania georgiae*[1] attacks three species of Calosoma in this country, namely, *calidum, frigidum,* and *sycophanta.* It is probable that the percentage of parasitism of Calosoma beetles by this tachinid is rather small, as only a few records of its work have been secured.

EXPERIMENT TO DETERMINE IF SKUNKS, FOXES, AND RACCOONS PREY UPON CALOSOMA BEETLES.

January 27, 1913, the junior writer took some living adults of *sycophanta* to Franklin Park Zoological Garden, Boston, Mass., and secured permission from Mr. J. T. Benson, curator, to isolate one skunk (which happened to be an old female), and these specimens were offered as food. The animal was placed in the cage about 10.30 a. m. and a cigar box one-half full of earth, containing four adult beetles, was put in at the same time. She scarcely noticed the box of earth at first, but by 12 m. had tipped it over and consumed the four beetles, leaving only two elytra. Two extra specimens were put in the cage at noon and these were quickly consumed. Excrement was passed in the afternoon of that day, but no parts of the beetles were found in it. The following morning excrement was removed from the cage. It was composed partly of undigested parts of *sycophanta,* including elytra, legs, and other chitinous appendages. (Pl. IV.)

The same sort of an experiment was conducted with a red fox (*Vulpes fulva*) and a raccoon (*Procyon lotor*), on January 25, 1913, at the Middlesex Fells menagerie, Stoneham, Mass. Mr. A. N. Habberley, superintendent of the Fells division, Metropolitan Park System, kindly permitted these animals to be used for the purpose. A cigar box of earth containing three males and one female *sycophanta* was placed in the cage at 9 a. m., but the fox would not notice them until Mr. Habberley and the junior writer had receded a short distance from it. In less than 10 minutes from the time they were put in the animal tipped over the box and consumed all the beetles. Later a fresh dead female was thrown into the cage and was eaten immediately. Excrement was found in the cage on the morning of January 27 which contained well-ground particles of the beetles.

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[1] Specimens have been described recently by Dr. C. H. T. Townsend as *Eubiomyia calosomae* coq.

The raccoon when offered adult *sycophanta* ate from the hand three males and two females in rapid succession. The beetles were ground up in coarse particles and were found in the excrement on the morning of January 27. The appearance of the remains in the excrement very much resembled those in the excrement of the skunk.

Even though the foregoing experiments were conducted under unnatural conditions, there is little doubt that these animals destroy *sycophanta* and other species of Calosoma in woodland where the beetles are plentiful. The skunk is the most important of these animals as a natural enemy of Calosoma in New England, as it is common in some sections, while the fox and raccoon are comparatively rare. In other sections of the United States the latter animals may prey upon Calosoma rather extensively.

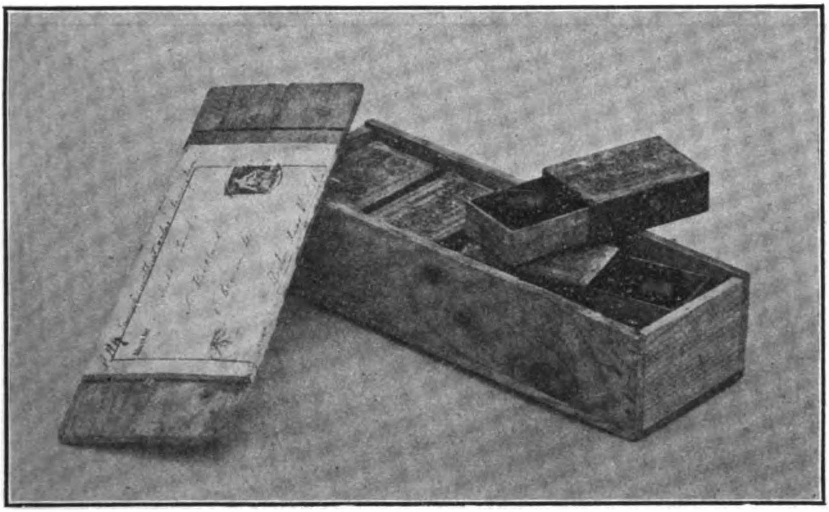

FIG. 1.—Boxes for shipping Calosoma beetles. Each match box contains a single beetle and a small quantity of wet sphagnum moss. (Burgess.)

METHODS OF SHIPPING CALOSOMA BEETLES.

During the past few years several thousand specimens of Calosoma beetles have been received and shipped. When live adults are to be forwarded and will not be in transit more than one day, they can be placed in a wooden box with a small amount of twigs and foliage and sent by express or mail. It is usually desirable to bore a few holes in the sides of the box and cover them with wire netting, but it is not necessary to add food for the beetles as they will survive the journey well unless the temperature is excessive.

When the length of time in transit is a week or longer, each beetle should be placed in a small box (a safety-match box is excellent for this purpose), with a small amount of wet sphagnum moss (fig. 1). No food need be added, but the packing should be such as to furnish some moisture for the beetles until the end of the journey.

In the writers' experience more specimens have died from lack of moisture than from any other cause. Metal containers are not desirable because too much moisture is present. The small boxes mentioned can be placed in a larger box and shipped by mail or express.

In case two or three weeks will be required for the journey it is desirable to ship in cold storage if the beetles are collected early in the season. Several lots have come from Japan that were shipped in this way during midsummer and they always arrived in good condition when the packing material did not become too dry.

METHODS OF REARING CALOSOMA BEETLES.

[Pl. V.]

Calosoma beetles are not easily reared, and as a rule considerable experience is necessary in order to manage the early stages successfully and obtain perfect adult specimens. All the species which have been under observation deposited their eggs in the ground and both male and female beetles usually spent a part of the time in the ground or under litter. When definite records are desired as to the number of eggs deposited by females or the molting periods of the larvæ, it has been found desirable to use glass battery jars containing from 2 to 4 inches of loam. A pair of beetles are placed in each jar and caterpillars added for food. A wooden cover provided with a groove which fits the top of the jar (fig. 2) has been found more satisfactory than covers made of cheesecloth or other material. A circular hole is made in the top of each cover and a piece of wire screen is tacked over it so as to afford free circulation of air and prevent the escape of the beetles. It has been found advantageous to attach narrow strips of wire netting to the top of the cover in such a manner that they extend nearly to the surface of the earth in the jar. The beetles are not able to climb the vertical sides of the jar, and as the caterpillars can do so easily the netting serves as a

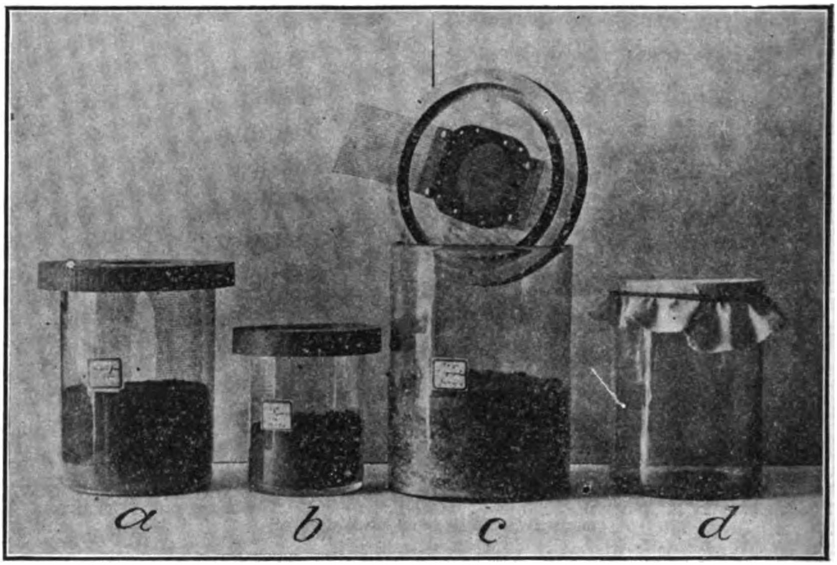

FIG. 2.—Jars for rearing Calosoma beetles: *a*, Large jar with wooden top and "ladder"; *b*, small jar with wooden top; *c*, showing construction of top and "ladder"; *d*, jar with cheesecloth top held in position with rubber band. (Burgess.)

ladder and permits the beetles to reach the top of the jar and feed upon any of the caterpillars that may crawl to this location. A small amount of foliage to serve as food for the caterpillars should be placed in the jar, and it should be cleaned daily and all dead specimens removed. This is necessary in order to prevent the development of certain species of mites that feed on caterpillar remains and in turn attack and sometimes kill the breeding beetles or larvæ. The earth should be examined from time to time to determine whether eggs have been deposited, and when they are found the beetles should be transferred to a fresh jar and the eggs allowed to remain undisturbed for hatching. As soon as larvæ appear they should be removed and placed in other jars containing earth. Ten larvæ of most species of Calosoma can be reared through the first stage in a jar of earth 6 inches in diameter, but if it is desired to carry the larvæ through to the adult stage each specimen should be placed in an individual jar, as they show a decided tendency to attack one another, especially at the time of molting. The size of the jars should be determined according to the size of the species which is to be studied, but in the writers' experience none of the species can be satisfactorily handled in jars less than 4 inches in diameter. In case definite records are not desired or if time is not available to care for a large number of individual jars, rearing can be carried on by using large cages, the bottoms of which are filled with earth (fig. 3). In all cases it is necesasary to keep the earth moist, but not wet. If too much water is added, the legs and mouthparts of the beetles and larvæ become coated with earth and the insects soon die. When the larvæ are fed in jars and it is desired to secure adult specimens, one of the most satisfactory methods is to construct small cylinders of

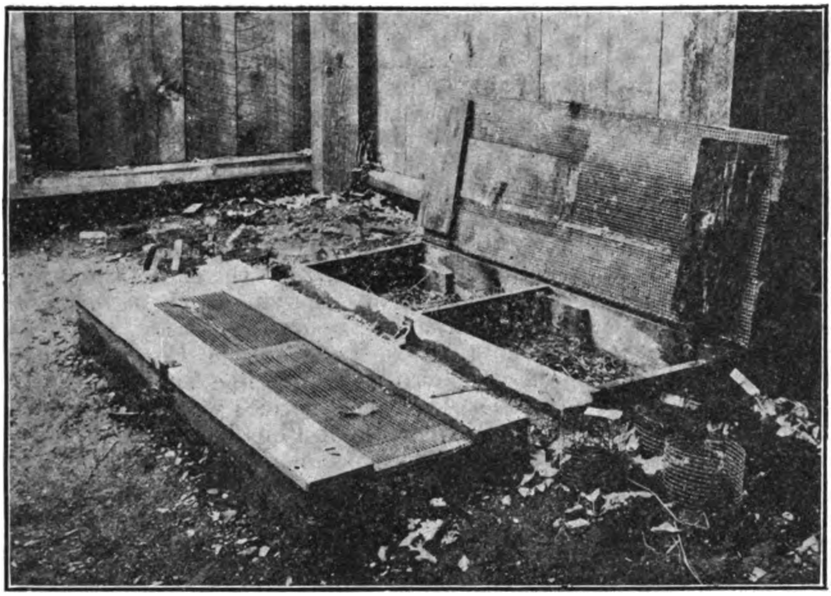

FIG. 3.—Box cages for hibernation of Calosoma beetles. (Burgess.)

mosquito wire netting about 4 inches in diameter. These should be sunk in the ground from 10 to 12 inches and the top should be closed with a wooden plug. The large larvæ can be placed in these cages, and if supplied with food will remain there and burrow into the ground when ready to pupate. Care should be taken to have the earth in these cages firm, but not too compact. In cases where it is loose the larvæ will not be able to form a satisfactory cavity in which to pupate and the insect will die before emerging as an adult. Many of the details in rearing Calosoma beetles must be learned from experience, but the general directions given above will serve to aid anyone desiring to carry on this interesting work.

CLASSIFICATION OF CALOSOMA.

The following table has been prepared for the separation of the species of Calosoma occurring in the United States. It consists simply of a revision of a similar table published by LeConte[1] in 1878, with a few changes and additions to include *sycophanta* L., *inquisitor* L., *reticulatum* Fab., and *auropunctatum* Payk., imported from Europe, and *chinense* Kirby and *maximowiczi* Mor., secured from Japan. All of these species have been liberated in New England except *auropunctatum* Payk. and *maximowiczi* Mor.. The former species has been studied at the laboratory, but not enough specimens were received for liberation. Only two females of the latter species were received from Japan, and as the classification is based on the characters of the male this species is added at the end of the table.

C. carbonatum Lec. is considered a synonym of *C. peregrinator* Guér.; *morrisonii* Horn, *prominens* Lec., *parviceps* Casey, and *tristoides* Fall have been added to those treated by LeConte, as they are apparently good species, the writers having had an opportunity to study specimens. A male of the last species was presented to the junior writer by Mr. H. W. Wenzel, of Philadelphia, as coming from the Ricksecker collection. One specimen of *C. dietzii* Schäf.[2] was also seen in Mr. Wenzel's collection and is evidently a good species, but could not be included in the table as the description does not give the characters of the male tarsi.

Col. Thos. L. Casey,[3] [4] in 1897, described the following species of Calosoma: *Sponsa*, *marginalis*, *parviceps*, *monticola*, and *arcuata*. In some cases these species were described from one or a very few specimens, and the types are held in his private collection. No other specimens of these species have been secured for study except *C. parviceps*. Some unidentified examples of this species were found in the collection at the U. S. National Museum. It has, therefore, been placed in the following table, but it has not been thought best to include the others on account of the small amount of material available.

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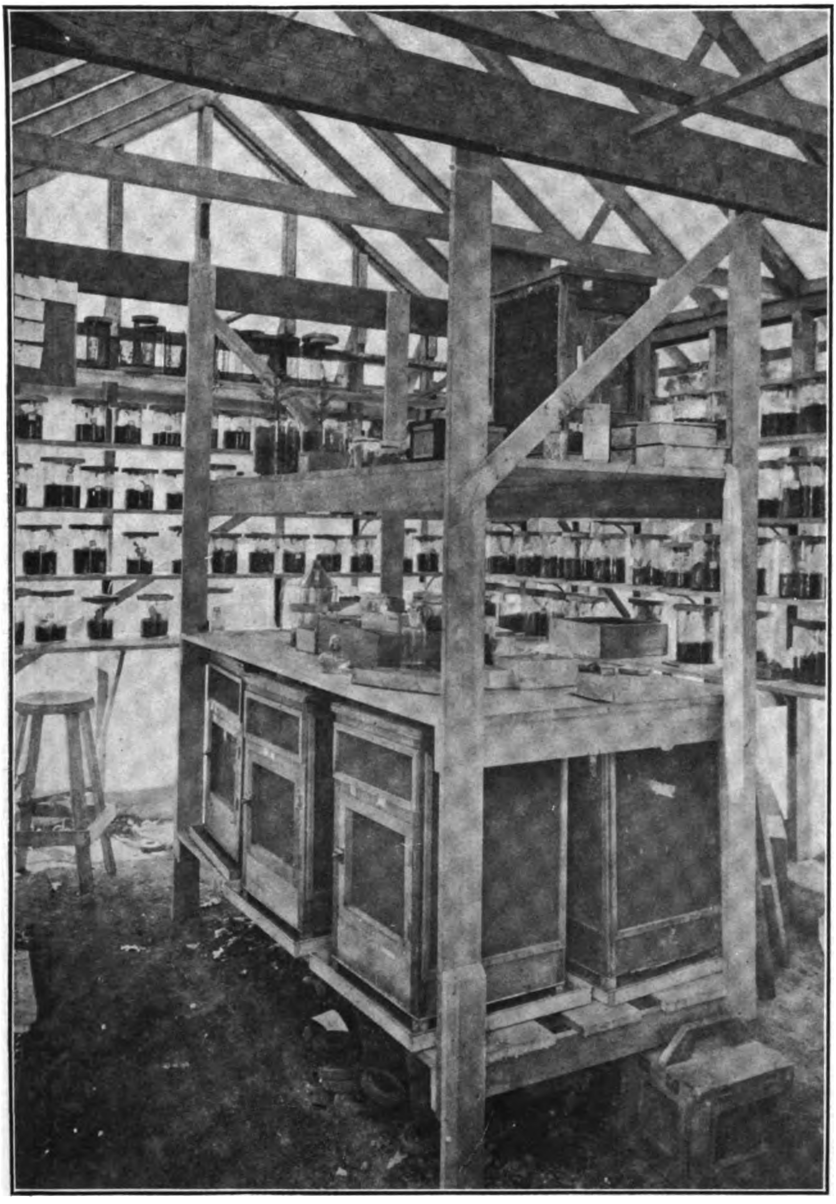
[1] LeConte, J. L. Description of a new species of Calosoma. *In* Bull. Brooklyn Ent. Soc., v. 1, no. 8, pp. 61-66, 1878.

[2] Schäeffer, Charles. New genera and species of Coleoptera. *In* Jour. N. Y. Ent. Soc., v. 12, no. 4, pp. 197-236, 1904.

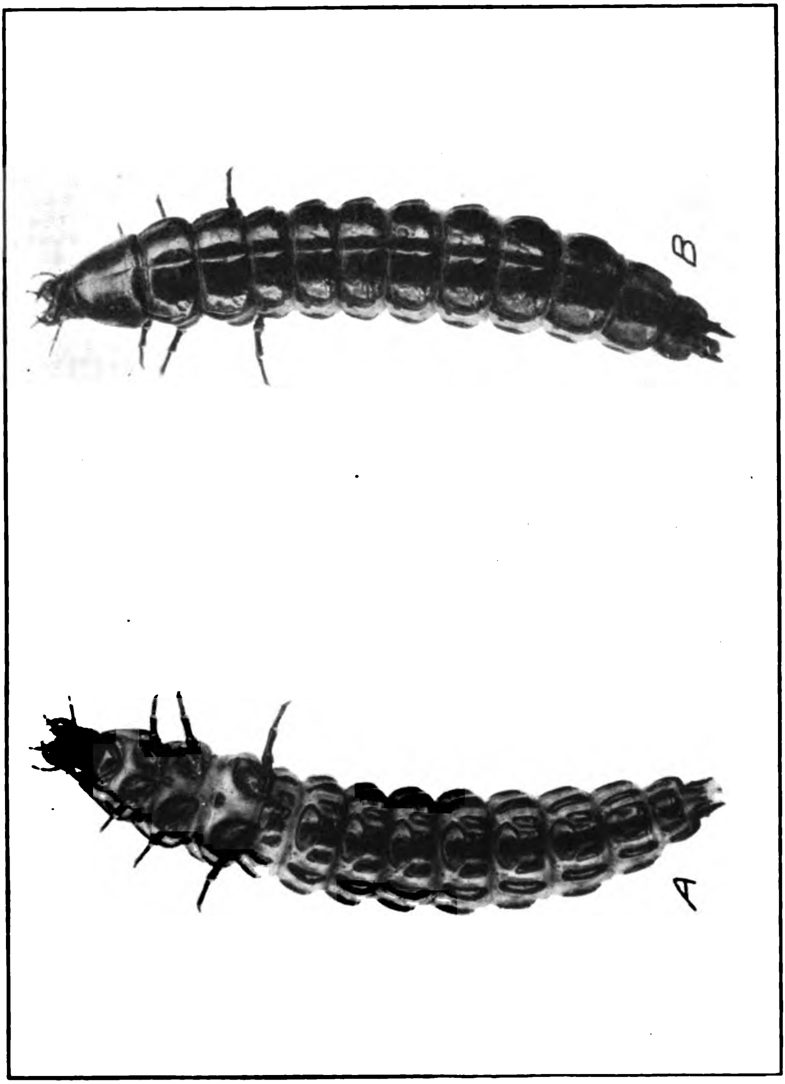
[3] Casey, T. L. Coleopterological notices. *In* Ann. N. Y. Acad. Sci., v. 9, pp. 285-683, 1896-1897.

[4] It might be added that Colonel Casey in the paper cited above also proposed several names of subspecies represented in his collection. These were *C. stellata*, a Lake Superior form of *calidum*; *expansa*, another form of the same species from Iowa; and *laticollis*, a third from Las Vegas, N. Mex. A form of *sayi* from Norfolk, Va., he considers as *virginica*, one of *frigidum* from Indiana as *levettei*, and one of *obsoletum* from New Nexico as *microsticta*. He also states that "*pimeliodes* Walk., *zimmermanni* Lec., and *striatula* Lec., are distinct species and should not be considered subspecies of *luxata*."



WHERE THE LIFE HISTORY OF CALOSOMA BEETLES WAS STUDIED.

Interior view of one of the outdoor insectaries at Melrose Highlands, Mass., where studies were made on the life histories of many species of Calosoma. (Burgess.)



CARABUS LIMBATUS.

A.—Third-stage larva, ventral view, ×4. *B*.—Same, dorsal view, ×4. Note difference in form of this larva from that of Calosoma and the different shape and arrangement of the ventral plates. (Original.)

Of the species described by Mr. H. C. Fall[1] in 1910, namely, *eremicola*, *parvicollis*, and *tristoides*, the writers have seen a representative of the last only, which is mentioned above. The other two could not be added to the table for separating the species, as the characters of the male tarsi are not given in the description.

TABLE FOR DETERMINING ADULTS OF CALOSOMA.

Anterior tarsi of male with joints 1–4 hairy beneath.
  Thorax with sides broadly flattened behind; body elongate, black.
    Elytra deeply striate, with blue border........................1. *externum.*
    Elytra smooth, with a few punctures on the basal half..........2. *macrum.*
    Elytra with series of fine punctures..........................3. *protractum.*
  Thorax narrowed behind, sides not flattened; elytra deeply striate.
    Elytra gold-green with red margin.
      Larger; middle tibiæ of male curved and with a dense brush of hairs on the inner surface near the tip.......................4. *scrutator.*
      Smaller; middle tibiæ of male straight, not hairy..........5. *wilcoxi.*
    Elytra black to slightly bronze, with three rows of small greenish-bronze punctures..6. *frigidum.*
    Elytra coppery to greenish-bronze, with coppery-green margins; punctures same shade as elytra.
      (Europe, introduced into Massachusetts).................7. *inquisitor.*
Anterior tarsi of male with joints 1–2 only hairy beneath.
  Thorax trisinuate behind, elytra deeply striate with three rows of golden foveæ...8. *sayi.*
Anterior tarsi of male with joints 1–3 hairy beneath.
  Green species with underside of body bluish-black or greenish-black; elytral spots faint and same color as elytra.
    Elytra deeply and regularly striate.
      (Introduced and established in New England)...........9. *sycophanta.*
    Elytra reticulate, granular.
      (Europe, introduced into Massachusetts)..............10. *reticulatum.*
  Black species without golden spots (faint bluish-green spots in *obsoletum*); striæ of elytra faint and obliterated behind (except in *angulatum*).
    Elytra narrowly margined:
      Side margin of thorax meeting the base in a well-defined angle (except in *parviceps*).
        Head coarsely punctured, thorax strongly angulated at the sides.
          Elytra deeply striate from base to apex.........11. *angulatum.*
          Elytra faintly striate from base to apex........12. *peregrinator.*
          Elytra faintly striate on basal half, becoming obliterated towards apex.
            Thorax strongly angled at sides............13. *prominens.*
            Thorax arcuate at sides.....................14. *parviceps.*
        Head with a few coarse punctures in front.
          Elytra with coarse transverse punctures near base..15. *lugubre.*
        Head smooth; thorax narrowly margined.
          Elytra nearly smooth, oval; wings feebly developed.16. *palmeri.*
      Side margin of thorax meeting the base in a curve.
        Thorax slightly bisinuate behind.
          Basal impressons slight; elytra nearly smooth........17. *triste.*
          Basal impressions broad; elytra with scaly sculpture. 18. *obsoletum.*
        Thorax emarginate behind, hind angles broad, prolonged.
          Without luster; transverse basal grooves of elytra as prominent as longitudinal striæ..........................19. *semilaeve.*
          Without luster; transverse basal grooves of elytra not as prominent as longitudinal striæ....................20. *simplex.*
    Elytra smooth, more broadly margined, oval; wings wanting (form robust, nearly as in *triste*)...................................21. *haydeni.*
    Elytra smooth, more broadly margined, oblong-oval; wings well developed (form robust and posterior angles of thorax not as broadly reflexed as in *triste*)...22. *tristoides.*

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[1] Fall, H. C. Miscellaneous notes and descriptions of North American Coleoptera. *In* Trans. Amer. Ent. Soc., v. 36, pp. 89-197 (pp. 90-92), 1910.

- Black species with golden or greenish-golden spots. (Spots sometimes faint in *tepidum* and *morrisonii*).
  - Thorax with broad basal impressions; elytral striæ regular....23. *calidum*.
  - Thorax with small basal impressions; elytral striæ frequently confused or faint.
    - Elytra of smooth sculpture, without imbricated appearance. 24. *morrisonii*.
    - Elytral striæ of medium depth and frequently confused..25. *tepidum*.
    - Elytral striæ fine, imbricate or transversely rugose. (Europe.)....................................26. *auropunctatum*.
- Bronzed species with three rows of chainlike elevations on the elytra; striæ confused.
  - Thorax less narrowed behind.
    - Basal impressions broad; wings well developed; elytra oblong-oval. 27. *cancellatum*.
    - Basal impressions shallow; wings wanting; elytra oval, less deeply sculptured..28. *subaeneum*.
  - Thorax more narrowed behind; basal impressions small; wings wanting; elytra oval...29. *moniliatum*.
- Bronzed species without three rows of chainlike elevations; with three rows of depressed greenish-golden spots.
  - Body elongate, tibiæ of mesothorax and metathorax of male curved. (Japan; introduced into Massachusetts and New Hampshire). 30. *chinense*.
- Black species with oval or rounded oval elytra, and without wings; thorax emarginate behind with the angles produced.
  - Outer joints of antennæ pubescent as usual:
    - Elytra broadly oval, with rows of close-set punctures and intermediate rows of more distant punctures........................31. *discors*.
  - Outer joints of antennæ pubescent only along the sides.
    - Elytra longer, oval, striæ confused, with three dorsal rows of larger punctures..32. *wilkesii*.
    - Elytra broadly oval, with distant rows of faint punctures; sculpture scaly, sometimes nearly smooth.
      - Hind angles of thorax not broadly rounded, sculpture rather rough. 33. *luxatum*.
      - Hind angles of thorax broadly rounded, sculpture smooth. 34. *latipenne*.

TABLE FOR DETERMINING CALOSOMA LARVÆ.

The table which follows gives characters for separating larvæ of different species of Calosoma. Full-grown specimens were used, as more satisfactory determinations can be made with them than with the earlier stages. The larvæ must have molted 24 hours or more before an attempt is made to classify them, otherwise the colors will not be normal. In order to show the difference in appearance of larvæ of this genus from those of Carabus, an illustration (Pl. VI) is given of a third-stage larva of *Carabus limbatus*. All measurements of larvæ have been made as follows: The length has been taken from the base of the mandibles to the posterior border of the anal segment, and the width has been measured at the middle of the mesothoracic segment.

The writers realize that this table is incomplete, but it covers the species which they have been able to study and is published at this time in the hope that it may assist anyone who wishes to determine some of the more common larvæ of Calosoma.

- With reddish-brown patch at base of caudal appendages in second and third stages.
  - Dorsum shining black in all stages except *scrutator*, which is sometimes brownish-black. Full-grown larvæ more than 30 mm. long.
    - Anterior ventral plate of first to seventh abdominal segments oval without noticeable dilation on anterior middle margin. Outside posterior ventral plates of same segments round without broad notch on inner

side. Posterior median plates rather oval in form save on sixth and seventh segments, where they appear somewhat truncate on inner margins; plates with broad median line of separation in well-fed larvæ. Posterior angles of anal segment pointing backward rather prominently. (Pl. XI, B.)

(Introduced and established in New England).......... *C. sycophanta.*

Anterior ventral plate of first to seventh abdominal segments oval, with noticeable dilation on anterior middle margin. Outside posterior ventral plates of same segments round to approximately square, often with broad and shallow notches on inner margins. Posterior median plates square to rectangular, truncate on inner margins of first 7 segments, plates with narrow median line of separation in well-fed larvæ. Posterior margin of anal segment truncate, posterior angles not pointing prominently backward. (Pl. IX, B.)

(Eastern, southern, and central United States and Canada). *C. scrutator.*

Dorsum brown to blackish-brown in second and third stages. Full-grown larvae less than 30 mm. long.

Caudal appendages stout, almost straight. Dorsal protuberances prominent, erect, located two-thirds length from base to apex.

Posterior angles of anal segment obtuse, not prominent and not protruding prominently backward.

(Eastern, southern, and central United States).......... *C. wilcoxi.*

Posterior angles of anal segment acute and extending backward rather prominently.

(Europe, introduced into Massachusetts)............. *C. inquisitor.*

Caudal appendages long, acute, usually slender. Dorsal protuberance short, stout, pointing slightly backward, located about one-half length from base to apex.

(Northern United States and Canada)..................... *C. frigidum.*

Without reddish-brown patch at base of caudal appendages in second and third stages.

Dorsum bronze to blackish-bronze in all stages; more prominent in second and third.

Caudal appendages very long, slender, slightly curved upward.

(Japan).. *C. chinense.*

Dorsum dull or shining black in all stages.

Caudal appendages short (less than 2 mm.), stout, curved slightly downward from base to apex.

Anterior ventral plates of first to seventh abdominal segments dilated at center, especially on anterior margins.

Posterior median plates of abdominal segments 2 to 7 inclusive with both median anterior and posterior angles rectangular.

Dorsal protuberance of caudal appendages stout, acute, rather erect, located in middle. Posterior angles of anal segment almost truncate. Larva robust. Dorsum dull black.

(Northern, eastern, and central United States and Canada. *C. calidum.*)

Dorsal protuberance of caudal appendages stout, acute, rather erect but located two-thirds length of appendage. Posterior angles of anal segments acute. Larva rather elongate. Dorsum shining black.

(Rocky Mountain section and southwestern United States.) *C. obsoletum.*

Posterior median plates of abdominal segments 1 to 6 inclusive with median anterior angles rectangular and posterior angles rounded.

Dorsal protuberance of caudal appendage short, stout, rather erect. Abdominal segments 1 to 8 each containing from four to ten small plates near lateral apices of anterior ventral plate.

(Pacific slope, Rocky Mountain section and the southwestern United States) .... *C. cancellatum.*

Dorsal protuberance of caudal appendage rather long, stout, extending backward in a straight line from basal half of appendage. Abdominal segments 1 to 8 each containing from two to five small plates near lateral apices of anterior ventral plate.

(California and Idaho)........................ *C. semilaeve.*

Anterior ventral plates of first to seventh abdominal segments not dilated at center.
  Plates with a prominent notch in center, anteriorly and sometimes posteriorly.
    (Southern and central United States)..............*C. lugubre.*
  Plates without notch in center anteriorly.
    Lateral plates somewhat circular in form; ventral plate on eighth abdominal segment somewhat rectangular, considerably broader than long; middle posterior notch in above plate obsolete or slightly marked—not as prominent as other two posterior notches.
      (Europe, introduced into Massachusetts)...*C. reticulatum.*
    Lateral plates elongate in form; ventral plates on eighth abdominal segment nearly square, middle posterior notch well marked and usually as prominent as other two posterior notches.
      (Europe)..............................*C. auropunctatum.*
Caudal appendages long (2 mm. or more), slender, straight, not bent downward beyond dorsal protuberance.
  Caudal appendages very long (2.5 mm.), slender and straight; dorsal protuberance short, not prominent; posterior angles of seventh and eighth abdominal tergites obtuse.
    (Eastern, southern, and central United States).......*C. externum.*
  Caudal appendages long (2 mm.), slightly angled downward beyond dorsal protuberance; posterior angles of anal segment and seventh and eighth abdominal tergites rather sharply pointed. Larva robust.
    (Western and southern United States)............*C. peregrinator.*
  Caudal appendages straight, long (2 mm.), straight beyond dorsal protuberance; posterior angles of anal segment obtuse, almost truncate; angles of tergites on seventh and eighth abdominal segments obtuse. Larva long, slender.
    (Rocky Mountain section and southwestern United States.)
C. haydeni.

GENERAL REMARKS.

On the following pages will be found a consideration of each species of Calosoma as it occurs in the foregoing table. The original description of the species is given, and also a statement concerning its distribution as secured from the literature and information furnished by curators and entomologists in charge of museums or collections of insects from all parts of the United States and Canada. The published information concerning each species is summarized and the results of the investigations which the writers have made dealing with the feeding habits, reproduction, and life history, are included and a bibliography of each species concerned.

Following the species given in the table have been added *Calosoma aurocinctum. C. dietzii, C. maximowiczi,* and *C. splendidum,* as these have been examined by the writers and have been found in greater or less numbers in the United States. They have not been placed in the table, as no male specimens were available for study.

MEASUREMENTS OF PUPÆ.

All measurements of pupæ that are given in descriptions were taken from the anterior margin of the prothorax to the end of the anal segment, and the width was measured at the center of the first abdominal segment.

CALOSOMA EXTERNUM (Say).

(Syn.: *C. longipenne* Dej.)

ORIGINAL DESCRIPTION.

East, Middle, South and Central States. Winged, black, margined with purplish; elytra with three series of obsolete punctures. Length one inch and three-twentieths.

Body elongated, deep black; antennæ brown at tip; thorax punctured, margined with bluish-purple; lateral edge regularly curved to the base; dorsal and basal lines distinct; basal angles obtusely rounded; elytra striate; striæ well impressed, much narrower than the interstitial lines, and with conspicuous, definite punctures; interstitial lines convex, equal, the 4th, 8th, and 12th each with a series of obsolete small punctures, which do not interrupt them; exterior margin bluish-purple.

A large species, brought from Arkansas by Mr. Thomas Nuttall. It somewhat resembles *C. sylvosus*, but is larger, the striæ of the elytra are much more regular, exhibiting nothing of the granulated appearance of those of that insect, and the curve of the exterior edge of the thorax is regular, or without any tendency to excurvature near the base.

EARLY RECORDS OF THE SPECIES.

This species was described by Thomas Say in 1823 from a specimen collected in Arkansas. Later Dejean discovered that *Carabus externus* Say and *Calosoma longipenne* Dej. were synonyms. Some valuable notes on the habits of both adults and larvæ have been recorded by Dr. L. O Howard and Prof. Lawrence Bruner.

DISTRIBUTION.

This species occurs in Arkansas, Connecticut, Delaware, District of Columbia, Georgia, Illinois, Iowa, Kansas, Kentucky, Maryland, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, and Texas. It is more common in the southern range.

COLLECTIONS AND SHIPMENTS.

Messrs. E. A. Schwarz and H. S. Barber, of the Bureau of Entomology, have collected at electric lights in Washington, D. C., and forwarded living specimens for study at the laboratory. In 1909 a female was received May 18 and a male June 7. June 19, 1910, one live female was received from Prof. C. E. Sanborn, Stillwater, Okla. In 1911, 6 males and 8 females were received from Washington, D. C., and in 1912 one pair of beetles was forwarded from the same locality.

HABITS OF ADULTS.

A small experiment conducted in June, 1911, to test the climbing habits of the adults showed that they are fairly agile on the bark of trees. They run swiftly on the ground and climb as actively as *C. frigidum*. During the short time the beetles were under observation they did not attempt to climb without being forced, but seemed thoroughly at ease when placed upon the trees.

FOOD OF ADULTS.

This species has been reported by Riley as feeding on the Rocky Mountain locust (*Melanoplus spretus* Uhl.), by Howard as an enemy of the army worm (*Cirphis unipuncta* Haw.), and by Bruner as feeding on *Lachnosterna* sp.

Daily records were kept of one pair of adults in 1909 from July 1 to August 23, when the male died. The female died July 26. The latter was received from Washington, D. C., May 18, and fed greedily upon raw beef until May 25. Caterpillars of *Malacosoma americana* were then supplied until July 1, and large numbers were consumed. One hundred and twenty-six sixth-stage *Porthetria dispar* caterpillars were consumed from July 1 to August 23.

In 1911 two pairs of adults were received from Washington, D. C., June 4, and placed in jars. Their feeding records are shown in Table 1.

TABLE 1.—*Feeding records of two pairs of Calosoma externum, 1911.*

Pair No.	Received and record started.	Ceased feeding.	Females died or entered hibernation.	Fifth and sixth stage caterpillars consumed.			
				Malacosoma americana.	*Porthetria dispar.*	*Estigmene acraea.*	Total.
5061	June 4	July 7	July 7[1]	52	77	....	129
5062	...do.....	Aug. 17[2]	Aug. 17[3]	40	153	27	220

[1] Female died; record closed.
[2] Record closed because of scarcity of food.
[3] Original female died July 5; another added on same date.

The usual custom is to discontinue feeding records when the female dies, but with No. 5062 another female was added on the same date and the record continued as long as food was available. The record was stopped August 17, but the pair was not transferred to a hibernation cage until August 26. Neither of the females included in Table 1 reproduced in 1911, which partly accounts for the comparatively small amount of food consumed, namely 129 and 220 caterpillars, respectively.

One pair of adults (No. 5097) fed in 1912. The female emerged from hibernation May 27 and died August 3; the male died July 24. One hundred and one full-grown caterpillars of *M. americana*, *M. disstria*, and *P. dispar* were consumed during the time and the female deposited eggs during the season.

The records at hand would indicate that the capacity of this species for consuming food is somewhat less than has been found with some other species of the genus. The records of *C. externum* secured are, however, rather incomplete, and more caterpillars would have been destroyed under natural conditions.

REPRODUCTION.

During the season of 1909 one pair of beetles reproduced very sparingly. The male was received June 7 and placed with the female on that date. On June 27 eggs were found in the jar, and on July 1 the pair were noted in copulation and again eggs were seen. They were scattered through the earth in the jar, but only two hatched, and no larvæ were reared.

During 1911 several beetles were received from Washington, D. C., in June and July, but no reproduction resulted that year. The beetles entered hibernation in the fall and lived to emerge in the spring of 1912. Pair No. 5097 produced 15 fertile eggs between June 1 and July 1. Copulation was noted June 1, 9, and 11, and the female died August 3. Female No. 5062 and female No. 5841 each deposited infertile eggs, which were not counted. The eggs were deposited June 7 to July 2, and one of the females died August 6, while the other entered hibernation August 30.

This species, like some of the other species of Calosoma experimented with at the laboratory, reproduced sparingly in jars. The same was true of *C. inquisitor*, *C. auropunctatum*, and *C. wilcoxi.*

LONGEVITY.

The one male and three females that emerged from hibernation in the spring of 1912 were collected in Washington, D. C., in the spring of 1911. All of these adults died in July and August, 1912, which indicates that the species lives at least two full years in the adult stage, as the beetles in question were larvæ and pupæ in the summer of 1910 or earlier and died in the summer of 1912. Three years is probably nearer the age limit of the species under natural conditions.

HIBERNATION.

All the beetles received from various sources in 1909 and 1910 died the same season without entering hibernation. Several adults, however, that were received during the spring and summer of 1911 ceased activity and entered hibernation August 12 and 26 and September 5. The same beetles emerged in the spring of 1912 on May 27 and 28 and June 3. The cavities, so far as could be determined, ranged from 1 to 3 inches deep. Three males and four females entered hibernation in the fall of 1911 and one male and three females emerged the following spring.

Adults of this species hibernated successfully at Melrose Highlands, Mass., through the winter of 1911–12, one of the most severe in this section for many years, which proves their hardiness when food and other conditions are favorable.

THE EGG.

Ten fresh eggs gave the following average measurements: Length, 5.4 mm.; width, 2.5 mm. They are somewhat elliptical in form with a slight taper toward one end. The color is white with a faint yellowish tinge. They vary greatly in form, ranging from long and almost cylindrical, tapering slightly at both ends, to short, oval, and somewhat kidney-shaped.

About 100 eggs were deposited by three females in 1912 but only 12 of these hatched. The fertile eggs were deposited June 4, 5, and 12, and 8 to 13 days were required for hatching. These records indicate that 8 or 9 days is the average time the eggs require for hatching during June.

DESCRIPTION OF LARVA.

First stage.—Form short, stout. Average length of 7 specimens, 7.7 mm.; width, 2.9 mm. Caudal appendages straight, very long (2.5 mm.), slender, bearing numerous short spines. Color black above, ventral plates dark to grayish-brown.

Second stage.—Form short, very broad. Average length of four alcoholic specimens, 13 mm.; width, 4 mm. Caudal appendages very long, the same length as in first stage but somewhat larger. Protuberance small, located about one-half the distance from base to tip. Ends of tergites, viewed from ventral side in partially fed larvæ, projecting well laterad, posterior angles of same obtuse and projecting prominently backward. Posterior angles of last segment short, rather acute. Color same as in first stage.

Third stage.—Form robust. Length of one alcoholic specimen, 20.5 mm.; width, 6.5 mm. Caudal appendages long, slender, spreading widely apart at tips. Protuberance short, acute, making angle of 45° with appendage, and located slightly more than one-half distance from base to tip. Tergites not protruding as far laterad in partially fed larvæ as in second stage. Color dull black on dorsum, ventral plates dark brown to grayish brown. No reddish-brown patch at base of caudal appendages in second and third stages.

TIME REQUIRED TO COMPLETE LARVAL STAGES.

The time required to pass through the different larval stages was only secured with the first two, as all larvæ failed to live through the third stage. Three larvæ hatched June 24, 1912, and died July 6, 9, and 11, while in the third stage. Two of these larvæ molted to second stage on the third day after hatching and one on the fourth. Three to five days were required to pass the second stage and the larvæ all died after 7 and 8 days in the third. An average of these records indicates that 3 days are required to complete the first and 4 days the second stage.

No pupal records could be obtained, as the larvæ died in the third stage.

FOOD CONSUMED BY LARVÆ.

So few larvæ were secured during the series of years these experiments were conducted and so many specimens died that the feeding records are far from complete. Two larvæ, all that hatched in 1909, were fed until both died while in the second stage. The first hatched July 6 and died July 13, consuming in the meantime five sixth-stage caterpillars of *Porthetria dispar*. The second hatched July 13, consumed three sixth-stage caterpillars of *Porthetria dispar* and was found dead July 23.

Records were kept of 12 larvæ that hatched during 1912; most of them died in the first stage but a few lived to reach the second and third. One larva consumed nine fourth-stage caterpillars of *Porthetria dispar* and another destroyed nine pupæ of the same species and died in the third stage.

The records at hand are so incomplete that a definite statement can not be given of the amount of food required by the larvæ. The adults are somewhat larger than those of *C. lugubre*, and it is probable that they require about the same number of medium-sized caterpillars or pupæ for the completion of their growth, or an average of 21. The feeding period probably extends over about 20 to 25 days.

HABITS OF LARVÆ.

During the season of 1912 some notes on the climbing habits of the larvæ were obtained. (Pl. III.)

June 24 two newly hatched larvæ were placed in the experiment. Many observations were made on these during the time they remained in the first stage and they made no attempt to climb. When placed upon the bark they would immediately crawl and wedge themselves under the nearest loose scales, and remain there for hours unless disturbed. In attempting to crawl they usually fell to the ground. The second-stage larvæ maneuvered in about the same manner when placed upon the bark of the tree. One crawled back and forth on a limb but when it attempted to climb up or down the trunk it immediately fell.

Third-stage larvæ were kept in the experiment from July 1 to July 11, when the last died. They were placed upon the trunk of the tree many times but climbed up very little before falling. One specimen crawled as much as 1 foot down the trunk from where it was placed before falling and this was the best record of progress during the experiment.

The larvæ in the three stages were kept under observation in the experiment from June 24 to July 11 without any indications of their having reached the food cage at the top of the tree. It was necessary to supply the larvæ with food on the ground in order to keep them from starving. All the data secured on the habits of the larvæ would indicate that under natural conditions they climb very little if at all. In this respect they possess habits very similar to those of *C. calidum*.

BIBLIOGRAPHY.

1823. Say, Thomas. Descriptions of coleopterous insects collected in the late expedition to the Rocky Mountains. *In* Jour. Acad. Nat. Sci. Phila., ser. 1, v. 3, pt. 1, p. 139–216.

Page 149. Original description of the species in comparison with *Carabus sylvosus* Say.

1831. DeJean, M. le Comte. Species Général des Coléoptères, de la Collection de M. le Comte De Jean, v. 5, 883 p. Paris.

Page 568. Description of *Calosoma longipenne* Dej. and note to the effect that it is *Carabus externus* Say.

1848. LeConte, J. L. A descriptive catalogue of the geodephagous Coleoptera inhabiting the United States east of the Rocky Mountains. *In* Ann. Lyc. Nat. Hist. N. Y., v. 4, p. 173–474 (445–446).

1877. Popenoe, E. A. A list of Kansas Coleoptera. *In* Trans. Kans. Acad. Sci. f. 1876, v. 5, p. 21–40.

Page 22. Occurs in "Western Kansas."

1878. Riley, C. V. Ground beetles. *In* 1st Rpt. U. S. Ent. Com. f. 1877, p. 313–314, fig. 45–47.

Page 314. Feeds on Rocky Mountain locust.

1878. LeConte, J. L. Description of a new species of Calosoma. *In* Bul. Brooklyn Ent. Soc., v. 1, no. 8, p. 61–66, 1878.

Page 64, 65. Synoptic table of Calosoma.

1883. Riley, C. V. The army worm. *In* 3rd Rpt. U. S. Ent. Com., p. 89–156, ills.

Page 125, pl. 1, fig. 8. Feeds on the army worm. The larvæ were found in remarkable abundance at Huntsville, Ala., by L. O. Howard under stones and logs; devours worms that creep in for shelter during the day.

1890. Bruner, L. Insects Injurious to Young Trees on Tree Claims. Univ. Nebr. Bul. 14 (Bul. Agr. Expt. Sta. Nebr., v. 3, art. 2), p. 83–149, 98 fig. 1890.

Page 117. Note of this species and *C. lugubre* being attracted to lights and their feeding upon May-beetles.

CALOSOMA MACRUM Lec.

ORIGINAL DESCRIPTION.

Elongated, black, shining, with front part of head scarcely punctate, with thorax one-half shorter than broad, narrowed towards the front, sides rounded, somewhat more broadly reflexed on the posterior, purplish, with truncate base, broadly marked on both sides; elytra scarcely broader than thorax, purplish margined, almost obsoletely striated, and punctures marked in triple series, thickly punctate here and there in front of the middle. Length 1.05 inches.

DISTRIBUTION.

J. L. LeConte described this species in 1853.[1] It occurs in Louisiana and Texas and a single specimen is present in the collection of the California Agricultural Experiment Station labeled "Md."

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[1] LeConte, J. L. Notes on the classification of the Carabidæ of the United States. *In* Trans. Amer. Phil. Soc., v. 10, n. s., pt. 3, art. 27, p. 364–403 (p. 400), 1853.

CALOSOMA PROTRACTUM Lec.

ORIGINAL DESCRIPTION.

Elongated, black, somewhat shining, with thorax twice broader than long, base scarcely notched, somewhat indented, with margin thickened; punctate at base and sides, sides reflexed more broadly posteriorly; elytra a little broader than the thorax, parallel, punctate finely in series. Length 0.95–1.05 [inches]. Arizona. Dr. Irvine, U. S. A.

DISTRIBUTION.

This species was described by LeConte in 1862.[1] It occurs in Arizona, Colorado, Kansas, and Mexico. Dr. F. H. Snow collected specimens at an altitude of 3,750 feet in Arizona.

CALOSOMA SCRUTATOR (Fab.).

ORIGINAL DESCRIPTION.

[Translation.]

Carabus, winged species, with striate elytra, green, with punctures in triple row, thorax dark blue; margin reflexed, golden. Habitat, Virginia. Very like the preceding (*sycophanta*). Thorax violaceous, with rounded margin, somewhat reflexed, golden. Margin of elytra golden. Abdomen green, spotted with gold. It varies sometimes in having abdomen entirely violaceous.

EARLY RECORDS OF THE SPECIES.

This species was originally described by Fabricius in 1775 and the type specimen or specimens were from Virginia. The species was given space under the genus Carabus in this author's other writings on Coleoptera until 1801, when he placed it in the genus Calosoma. This species attracted the attention of other early and prominent writers like Olivier, Latreille, Say, and Dejean. Chapuis and Candèze in 1855 were the first authors to figure and describe the larva. Riley, between 1870 and 1880, frequently wrote of the usefulness of this species as an enemy of the forest tent caterpillar (*Malacosoma disstria*) and cankerworms. Numerous other entomologists of the United States, Canada, and even some of those of European countries, have collected and published many valuable notes on this important economic species.

DISTRIBUTION.

This species occurs in Alabama, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maryland, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Rhode Island, Tennessee, Texas, and Virginia. It has also been found in Ontario, Canada, and in Mexico.

COLLECTIONS AND SHIPMENTS.

Through the kindness of Messrs. E. A. Schwarz and H. S. Barber, of the United States National Museum, many specimens of this species, along with specimens of *C. wilcoxi* and *C. externum*, have been received at the gipsy moth parasite laboratory for study and experimental work. All of the material shipped by these collectors was taken at electric lights in Washington, D. C. One live female was received from Prof. C. E. Sanborn, Stillwater, Okla., in 1910. Others were collected by Messrs. J. V. Schaffner, jr., at Dover, Mass., A. M. Wilcox, at Cohasset, Mass., and N. W. Souther, at Onset, Mass.

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[1] LeConte, J. L. Notes on the species of Calosoma inhabiting the United States. *In* Proc. Acad Nat. Sci. f. 1862, v. 14, p. 52–53, 1863.

From 1909 to 1912, 82 males and 98 females were received. Those collected in Washington, D. C., arrived between May 12 and July 8, and most of them reached Melrose the last half of May. The Massachusetts specimens were collected in June, July, and August.

HABITS OF ADULTS.

In the climbing experiment (Pl. III) a pair of adults when released proceeded directly to the base of the tree and then to the top. After climbing around the tree a few times with great ease and swiftness the pair were seen in coitu on the side of the trunk.

On June 16, 1911, 7 males and 6 females were released in a greenhouse at Brighton, Mass., where *Asparagus plumosus* is grown. Some of the beetles were placed upon the asparagus stems and leaves to ascertain if they could climb these small and slippery stems. One female climbed to the top of one plant which was about 15 feet high, then continued up the twine, around which the plant grew, about 8 feet farther to where it was fastened, and was then lost to view. Another adult ascended to the top of a plant and remained on a leaf for a short time.

May 28, 1909, 24 males and 33 females were placed in a large compartment of an outdoor cage to observe their habits of climbing and feeding. The cage was covered with fly-screen wire and measured 2 by 4 by 8 feet high. Caterpillars were supplied daily for food and the following notes were secured:

June 2, Mr. Burgess observed the beetles in the foregoing cage until 9 p. m. It was a moonlight night but the cage was quite dark as the light was obscured by the laboratory building. At the advent of darkness the beetles became very lively and ran about on the walls of the cage. They also flew about in the cage and were more active than during the day, at which time they usually remained at the top. Several were noted feeding upon caterpillars on the side of the cage. They did not appear to hunt the caterpillars as much as did *C. sycophanta* but when one crawled by they seized and devoured it greedily. The beetles would cling to the side of the cage head down and hold the caterpillars in their mandibles while feeding and occasionally carried them about in their jaws for some time before finishing them. (Fig. 4.) A considerable percentage of the caterpillars were killed and devoured by the beetles in this cage during the night. After dark the beetles made a droning noise, probably by moving the wings rapidly, which was audible for quite a distance from the cage.

Larvæ of *C. scrutator* were observed crawling about in this cage at various times during the summer. They attacked the largest caterpillars on the ground but were not seen climbing on the sides.

FOOD OF ADULTS.

These beetles have been reported as feeding on the following species of insects: Cankerworms, tent caterpillars, army worms, (*Hibernia*) *Erannis tiliaria* Harr., (*Aletia*) *Alabama argillacea* Hbn., and (*Cacoecia*) *Archips fervidana* Clem.

April 1, 1910, the following note was taken from a letter received from Mr. J. J. Davis: "Several years ago at an electric light at Urbana, Ill., I noticed the species *Calosoma scrutator* actively engaged in eating the June beetles as they would light on the pavement." No attempts were made at the laboratory to ascertain the number of different species of insects upon which the beetles would prey. Daily feeding records (see Table 2) were kept of four pairs of adults received about the middle of May, 1909, the beetles being supplied with such food as was most available at that time. The beetles were offered raw meat, of which they partook sparingly until about May 25, when the caterpillars of *Malacosoma americana* had reached a fair size. The daily records were then started and continued until the beetles either died or entered hibernation in the fall.

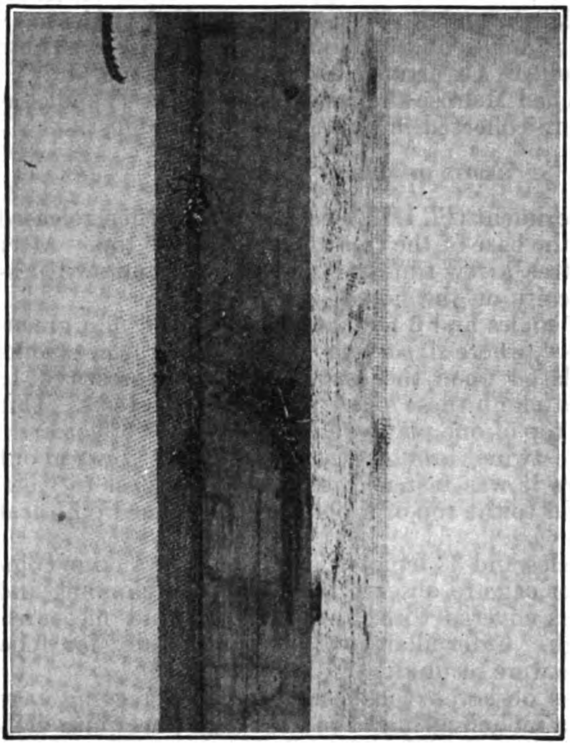


FIG. 4.—*Calosoma scrutator* feeding on a caterpillar in a large cage. (Original.)

TABLE 2.—*Feeding records of four pairs of Calosoma scrutator, 1909.*

Pair No.	Feeding record started.	Ceased feeding.	*Malacosoma americana*, third to sixth stages.	*Porthetria dispar*, sixth stage.	*Hyphantria cunea*, third to sixth stages.	Total.
1772	May 16	Sept. 24[1]	315	257	143	715
1786	26	July 23[2]	234	42	....	276
1787	23	27[3]	336	138	....	474
1789	26	Sept. 18[4]	277	194	97	568
Average...		....	....	....	....	508

[1] Female died Aug. 11.
[2] Female died June 26.
[3] Female died July 16.
[4] Male died Aug. 25.

All the pairs cited above reproduced as is shown in Table 4; this accounts for the enormous amount of food eaten, which averaged 508 caterpillars per pair. The writers believe that the average would be slightly lower than this if more experiments had been conducted, especially if some of the females did not oviposit. In two of the experiments the beetles fed unusually late and the records were started somewhat earlier than the normal time of activity in New England. The average feeding period of this species about Washington, D. C., is probably from May 15 to Sept. 1 or 15, and in New England from June 1 to Sept. 15.

From a lot of larvæ that hatched September 23, 1909, two pairs of adults issued from cavities at the bottom of jars between November 16 and 21, and immediately came to the surface in search of food. The beetles were kept in jars of earth in the laboratory at a temperature of about 72° F., during the day. Various living insects were offered for food and none of them was refused. The feeding records are given in Table 3.

TABLE 3.—*Feeding records of two pairs of young adults of Calosoma scrutator, fall of 1909.*

Pair No.	Insects eaten.	Number.	Pair No.	Insects eaten.	Number.
2857	*Alsophila pometaria*	[1] 4	2558	Full-grown *Pontia rapæ* caterpillars	22
	Full-grown *Carpocapsa pomonella* larvæ	12		Full-grown *Tenebrio molitor* larvæ	23
	Full-grown *Pontia rapae* larvæ	29			
	P. rapæ pupa	1			
	Full-grown *Tenebrio molitor* larvæ	31			
	Total	77		Total	45

[1] Females.

On December 15 all the beetles buried themselves in the earth for hibernation and the jars were transferred to the laboratory cellar where they remained until the following spring. In this experiment the beetles came to the surface and fed as soon as they entered the adult stage. Adults of *C. sycophanta* seldom do this, but remain in the pupal cavity until the following spring. In feeding, the beetles showed no preference for the species mentioned in Table 3. These were supplied because they could be most easily secured.

This record was obtained under laboratory conditions and would not apply under natural conditions in New England. It indicates that late fall emergence of the beetles may take place in the southern range.

REPRODUCTION.

The largest number of eggs deposited in a single season by one female was 396. Records were kept of five pairs that reproduced in 1909 to show the number of eggs deposited daily by each female. These records are given in Table 4.

TABLE 4.—*Record of eggs deposited by five pairs of Calosoma scrutator, 1909.*

Date.	Pair No. 1772.	Pair No. 1786.	Pair No. 1787.	Pair No. 1789.	Pair No. 2704.
June 14	......	......	42	......	......
17	......	......	1	......	......
18	......	......	18	......	......
19	......	......	30	1	......
20	......	......	10	15	......
21	38	......	42	67	25
22	......	4	57	40	13
23	68	......	22	27	33
24	......	30	14	9	19
25	......	17	11	2	......
26	46	......	35	31	19
27	......	18	30	......	3
28	......	8	......	......	......
June 29	......	7	52	20	24
30	......	......	19	2	......
July 1	......	......	2	......	4
2	4	......	11	20	36
3	4	......	......	......	1
9	1	......	......	......	......
15	......	......	......	......	11
16	......	......	(1)	......	......
19	......	......	......	......	17
Aug. 1	......	......	......	......	(1)
11	(1)	......	......	(2)	......
Total..	161	84	396	234	177

[1] Female died.

[2] Female entered hibernation.

After the females had ceased oviposition at the end of the season the males in each of the four jars died. They were replaced with males from the same shipment, but all the females died soon after, except one (No. 1789) which entered hibernation and again laid eggs in 1910. This female deposited 26 fertile eggs in 1910 and died during the summer. Table 4 is inserted to show the duration of oviposition each year and indicates the large number of eggs sometimes deposited by a female in a single day.

The total number of fertile eggs deposited by two females in 1910 was 81. There were other females in stock but they did not deposit eggs. Other beetles received during the first days of June and July, 1911, did not deposit eggs that year.

LONGEVITY.

One female that was received from Washington, D. C., May 18, 1909, lived until July 21, 1910. This adult reproduced in both 1909 and 1910 and a few other specimens lived as long as this female, but no record was kept concerning reproduction. The age of these beetles was unknown at the time they were received but most of the specimens lived two years in confinement.

It is probable that the length of life is considerably greater under natural conditions.

HIBERNATION.

The notes at hand on the hibernation of this species present some great variations as to the time of entering and emerging. Of the beetles received in the spring of 1909, those that lived until the fall entered hibernation between September 8 and October 12. The first female of this lot emerged May 9, 1910, and one on each of the following dates: May 26 and June 4, 12 and 16. One male emerged June 30. The depth of the cavity of only one female could be determined and this was 1 inch below the surface.

One pair of beetles collected at Onset, Mass., during August, 1909, reproduced during the latter half of September and entered hibernation October 8. The female died during the fall or following winter and the male was unearthed from a cavity 9 inches deep in the hibernation cage June 23 the following summer.

Two pairs of young stock, reared in the fall of 1909 from the parents cited in the preceding paragraph, entered hibernation on December 16 in jars of earth kept in the laboratory. These jars containing the pairs were transferred to the laboratory cellar which retains a temperature of from 30° to 50° F. during the winter. At the advent of spring these jars were again transferred to a shelf in an outdoor cage. The beetles hibernated in cavities at the bottom of large battery jars and could be seen from the outside. The females emerged July 6 and 11, respectively, and until July 18 the males had not shown any signs of activity, at which time they were removed from their cavities and placed on the surface. One of the females died during the summer of 1910, and the remaining two males and one female reentered hibernation September 7 and 13. None of these lived to emerge in the spring of 1911, but two of the males were found dead, 3 and 8 inches deep in the earth.

It appears from the foregoing notes that one might expect normal adults of this species in New England to enter hibernation from September 1 to 15 and emerge the following spring from June 1 to 15, depending entirely upon the season.

The cavities ranged in depth from 1 to 9 inches in loose loam such as was used in the foregoing experiments.

THE EGG.

[Pl. VII, *A*.]

The average length of 8 eggs which had been preserved in alcohol was 5 mm., and the average width 2.3 mm. The largest egg measured was 5.5 mm. long and 2.5 mm. wide. Fresh eggs of this species appear to be somewhat larger than those of *sycophanta*; hence the latter measurements would probably be more correct for fertile eggs soon after deposition.

The eggs are white, with a faint yellowish tinge, nearly elliptical in form, slightly tapering toward one end; in fact, they present the same general appearance as those of *sycophanta*.

The time in the egg stage varied from 3 to 14 days, the general average being 6.84 days as secured from a large number deposited in 1909 by several females. The eggs were deposited between June 4 and July 15. Similar data were secured from the hatching of 81 eggs in 1910, deposited from June 21 and June 24, inclusive. The average time required for the hatching of this lot was five days. Oviposition in the latter case took place entirely during the last days in June when the temperature was more even, and resulted in the development of the eggs in a shorter time. (Pl. VII, *B*.)

DESCRIPTION OF LARVA.

First stage (Pl. VIII, *A*, *B*).—Large, robust larva. Average length of 10 specimens, 9.5 mm.; width, 2.5 mm. Caudal appendages of medium length, rather stout. Color very dark brown to black, ventral plates light brown.

Second stage (Pl. VIII, *C*, *D*).—Form similar to that in first stage. Average length of 8 specimens, 16.9 mm.; width, 4.4 mm. Caudal appendages, short, stout, and straight. Color same as in first stage.

Third stage (Pl. IX, *A*, *B*).—Very large, robust larva. Average length of 10 specimens, 25.6 mm.; width, 5.6 mm. Posterior margin of ninth abdominal segment usually truncate, angles not prolonged. Caudal appendages straight, very stout near base; dorsal protuberance short and acute, located about one-half distance between base and tip. Color very dark brown and black, shining. Ventral plates light brown. Reddish-brown patch at base of caudal appendages in second and third stages.

The foregoing measurements were made from alcoholic specimens, while those of most other species were made from living material.

LENGTH OF TIME REQUIRED TO COMPLETE LARVAL STAGES.

The larvæ that were reared in June and July, 1909, completed the first stage in an average of 3 days; the second in 3 days; and the third in about 15 to the date the larvæ ceased feeding. The whole active period of the larvæ covers about 21 days for the series reared early in the season.

For the series that were reared in the fall of 1909, 4 days were required to pass the first stage, 10 days for the second, and 14 for the third to the date the larvæ ceased feeding, making a total of 28 days for the active feeding period.

The time elapsing between the date the larvæ ceased feeding and the date of pupation was secured from the series reared in the fall of 1909 and seven days were required at a temperature of from 68° to 75° F. The prepupal stage, like the larval stages, is probably shorter in the summer when the temperature is high and other conditions more favorable to development.

FOOD CONSUMED BY LARVÆ.

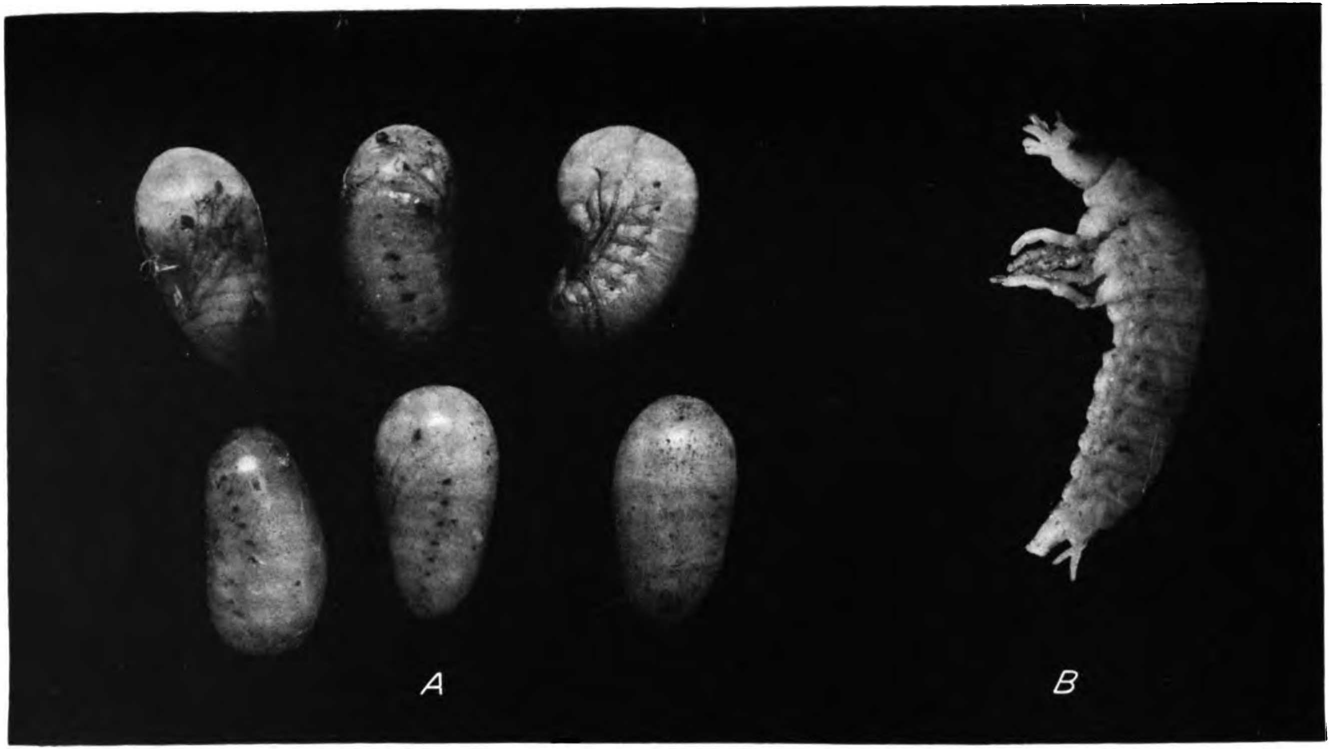
A large series of individual feeding records of larvæ was conducted, using jelly glasses about two-thirds full of earth. Very poor results were secured with such small containers. All of the larvæ in this series died before pupation. The records of six specimens that reached maturity before death are given in Table 5 to show the number of caterpillars destroyed by each.

TABLE 5.—*Food eaten by larvæ of Calosoma scrutator.*

Hatched.	Ceased feeding.	*Malacosoma americana*, fourth and fifth stages.	*Porthetria dispar*, fourth and sixth stages.	Grand total.
1909.	1909.	*Total.*	*Total.*	
June 22	July 9	6	28	34
22	10	4	25	29
22	8	7	38	45
22	21	6	33	39
22	13	5	31	36
22	13	5	31	36
22	14	7	22	29
Average.	....	....	....	36

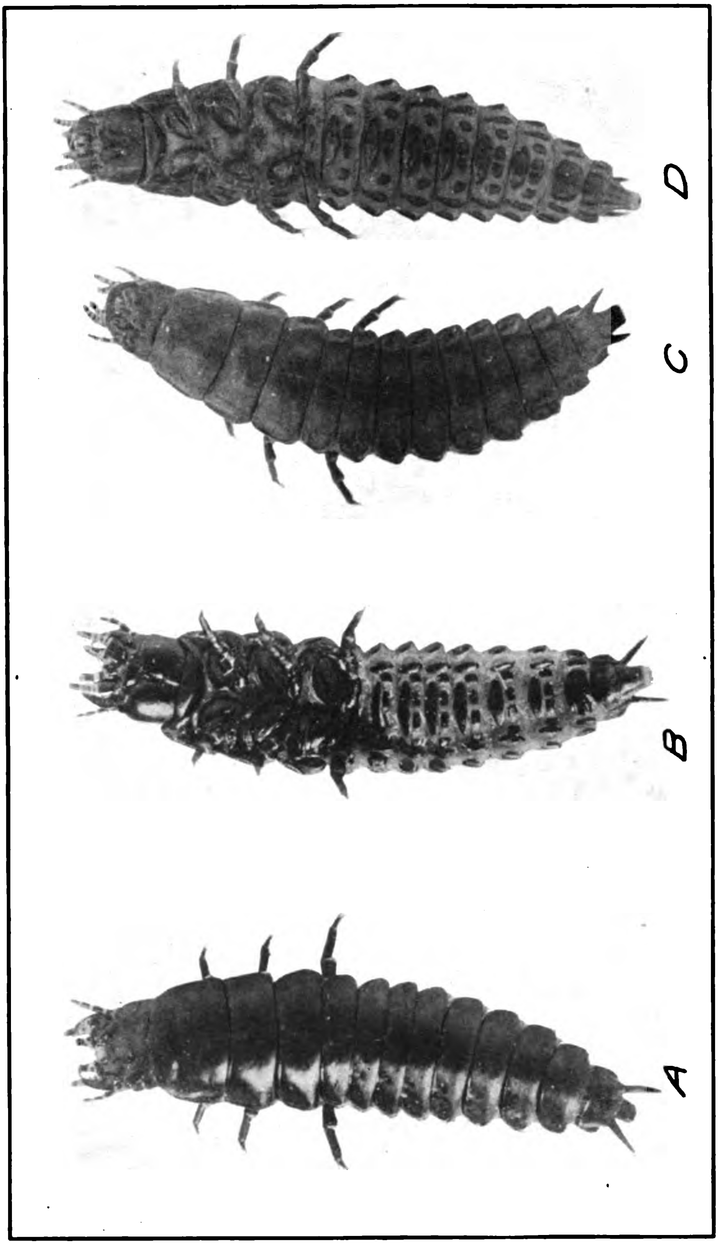
The average number of mostly full-grown caterpillars consumed by each of these larvæ was 36. Using larger jars, giving each larva more freedom, or under natural conditions, the writers believe that larvæ of this species will destroy as many large caterpillars as *C. sycophanta*, which was reported in Bulletin 101 of the Bureau of Entomology to destroy an average of 41. The active feeding period of *C. scrutator* in this series extended over 21 days, and this would have been somewhat longer under more satisfactory conditions.

It was proven in 1912 that these larvæ consume with equal greed pupæ of *Malacosoma americana* and *Porthetria dispar*. One larva that hatched June 24 of that year consumed 31 pupæ of these lepidopterous species while other larvæ consumed 15 to 18 pupæ before becoming full-grown.



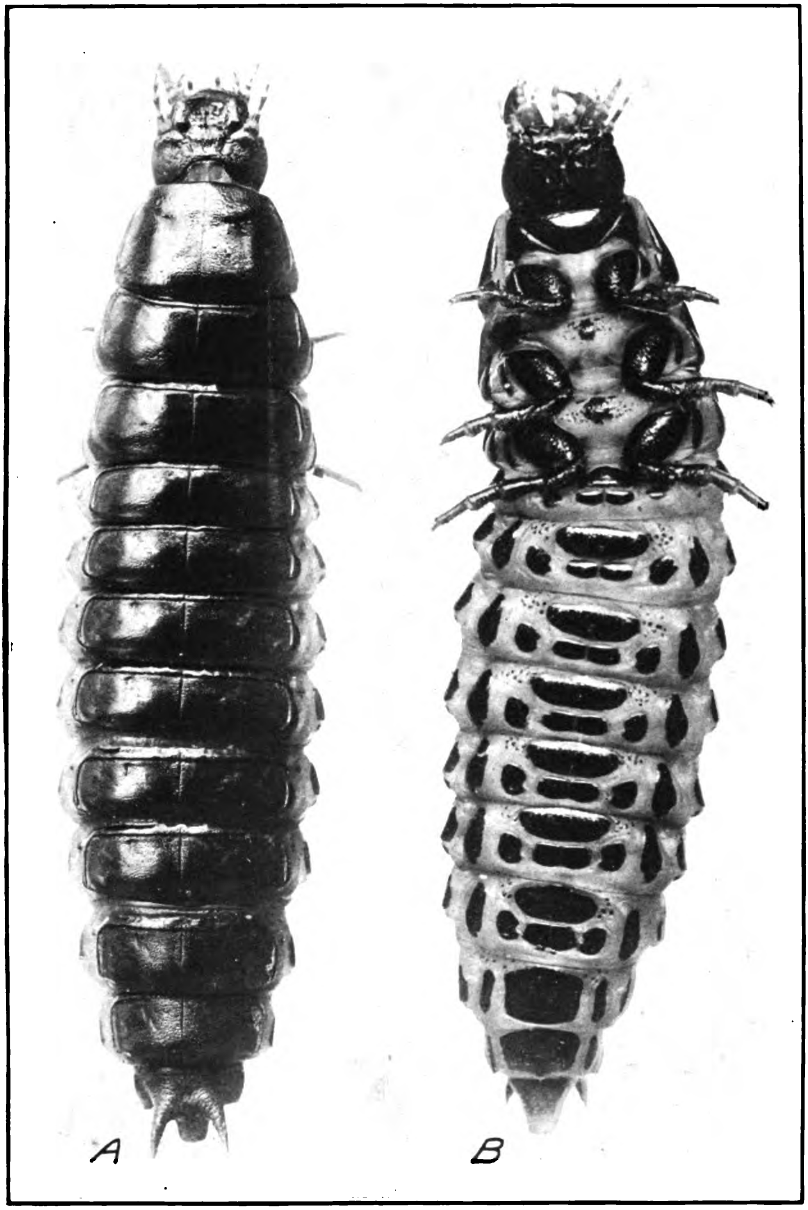
CALOSOMA SCRUTATOR.

A.—Eggs showing different degrees of embryonic development, ×6. *B*.—Newly hatched larva, ×6. (Original.)



CALOSOMA SCRUTATOR.

A.—First-stage larva, dorsal view, ×6. *B.*—Same, ventral view, ×6. *C.*—Second-stage larva, dorsal view, ×4. *D.*—Same, ventral view, ×4. (Original.)



CALOSOMA SCRUTATOR.

A.—Third-stage larva, dorsal view, ×4. *B*.—Same, ventral view, ×4. (Original.)

HABITS OF LARVÆ.

Experiments were tried with larvæ of this species in all stages to secure data on their habits of finding food, using the apparatus shown in Plate III.

June 24, 1912, Mr. Dudley began an experiment with two first-stage larvæ. They were placed several times upon the bark of the tree, as they did not seem to venture there of their own volition. When this was done they would either fall to the ground or advance to the nearest loose scale of bark in their path and remain there until disturbed.

June 26 and 27, the two larvæ molted to second stage. They acted in a similar manner in this stage. They were usually found buried in the earth in the morning instead of in the food cage at the top of the tree.

On July 2, one larva died in the second stage and the other molted. The third-stage larva was put upon the bark of the tree several times and would climb 6 to 12 inches around or down the tree before falling. This larva became rather sluggish by July 12 and was removed from the experiment.

July 16, the junior writer liberated two large third-stage larvæ inside the circle, and observed their movements at intervals for two days, after which time they were becoming exhausted from lack of food. One larva, when placed upon the trunk, ascended 12 inches before falling, which was the best record for distance covered during the period of the experiment.

These experiments were repeated in 1913 with practically the same result, except that in one case a first-stage larva after being placed upon the tree was able to climb about 4 feet before falling. This is the best record made by any larva of this species but hardly indicates that the species commonly climbs to any marked extent.

The movements of these larvæ are very similar in all stages to those of *C. calidum* and *C. frigidum.* It was necessary to remove the larvæ from the experiment at intervals in order for them to feed, indicating that this species must secure food on or near the ground.

COLONY AND CAGE EXPERIMENTS IN GREENHOUSE.

During the early spring of 1910 it was necessary to secure lepidopterous larvæ with which to feed specimens of Calosoma and Carabus after their emergence from hibernation. After much inquiry, a supply was found in a range of greenhouses at Brighton, Mass. The proprietor is a wholesale grower of roses, *Asparagus sprengeri,* and *Asparagus plumosus* and his greatest insect pest on asparagus is a cutworm, *Noctua clandestina* Harr. There are several generations annually and the proprietor and foreman report that the worms can be found in various stages during most of the year. The proprietor resorts to poisoned bran mash and hand picking to combat the pest. He claims an annual loss of $2,500 from this insect which includes $1,000 expended for hand picking at night and other methods, and $1,500 damage as a result of the cutting off of the tender terminals of the plants, which checks their growth.

Cutworms collected by the laborers at night were used to feed Calosoma and Carabus. In return for this act of kindness in forwarding them daily to the laboratory during the early spring, an experiment was started to ascertain if predacious Calosoma could be induced to prey upon the pest.

In June, 1910, five males and three females of this species were placed in one greenhouse, in a wire cage, 2 by 1½ by 1½ feet. A number of asparagus plants were growing in this cage and cutworms were added from time to time.

On August 17, 1910, three adults were climbing about on the sides of the cage. No dead beetles had been removed, nor had there been any reproduction observed by the foreman. The cage was not visited again by the junior writer until March 21, 1911, when two males were active, climbing on the sides of the cage. The foreman stated that the beetles were first active in the cage about February 1, 1911. A dead beetle was removed at that time.

June 16, 1911, the earth in the cage containing the beetles was examined and three males were found in separate well-made cavities at the bottom. The walls of one of the cavities was secured unbroken and the beetles appeared dormant when first disturbed. On this date these beetles had lived in greenhouse temperatures and conditions for one year, thoroughly demonstrating their ability to withstand similar conditions. The foregoing notes show that they do change their habits somewhat to suit conditions, in being alternately active and dormant throughout the year. Two males and two females were replaced in the cage on this date and further observations were made for reproduction of the species in 1911. By August 7, one pair had died and still there was no evidence of reproduction although this might have taken place and the young larvæ escaped through the meshes of the fly screen unnoticed, but it is rather improbable.

On the same date (June 16, 1911) seven males and six females were liberated in the beds of *Asparagus plumosus* in an adjoining house. Some of these beetles were placed upon the asparagus leaves and on these they climbed for a while but soon fell to the ground and disappeared.

June 29 and August 7, 1911, the colony was visited to ascertain if the beetles were reproducing, but no evidence was secured. Neither Mr. Harbeson nor the laborers had seen any of the beetles since they were liberated save one dead specimen that was found about June 25. At this time the men were finding both adults and small cutworms of *N. clandestina*.

June 6, 1912, 3 males and 6 females that had just been received from Washington, D.C., were added to the colony, which now totaled 10 males and 12 females liberated. The colony was visited several times during the year, namely, February 3, April 8, May 29, June 6, and September 25, and examinations made, but there was no evidence that the beetles reproduced.

Although reproduction was not noted with any of the beetles in the greenhouse up to the end of 1912, larvæ might have been present in small numbers.

It is not strange that it did not occur or was unnoticed with so few beetles in a large greenhouse. It is demonstrated in the following paragraph that adults of this species feed upon cutworms during the night when the latter come to the surface of the earth to obtain food, and the writers still have hope that this species may prove a beneficial enemy of cutworms under these conditions. In this case it was possible for the beetles to escape, as the ventilators and doors were frequently left open.

EXPERIMENT TO DETERMINE THE RELATIVE AMOUNT OF FOOD DEVOURED BY ADULTS DURING DAY AND NIGHT.

In connection with the idea of colonizing this species in a greenhouse where cutworms (*Noctua clandestina* Harr.) are abundant several times in the year, it was thought advisable to secure some information on the feeding of this species upon cutworms. Two large battery jars two-thirds full of earth, each containing one male and two females, were used for the experiment. In one jar cutworms were buried in the earth at 5 p. m. and the jar immediately set in a dark closet until 8 a. m. the following morning when the count of devoured and unharmed cutworms was made. All living cutworms were removed until 5 p. m. on this day when they were returned to the jar with others. In the other jar cutworms were buried at 8 a. m. and the count of devoured and living was taken at 5 p. m. They were then removed from this jar until 8 a. m. the following morning. Green grass was placed on the surface of the earth in the jars each time to furnish food for the cutworms and the latter were buried about one and one-half inches below the surface.

The experiment was started June 19 and concluded June 28 because the supply of food was no longer available. After June 24 the cutworms were left in the jars all the time, but records of feeding were made at 5 p. m. and 8 a. m. Fifty-seven full-grown cutworms were devoured by the beetles during the night and four during the day, or 14 times as many were eaten at night as during the daytime. It is evident from these experiments and other jar records that the adults of this species burrow into the ground very little in search of food but take the opportunity to seize their prey whenever it is met (day or night) on or above the surface of the ground. This species destroys large numbers of cutworms as well as arboreal caterpillars.

THE PUPA.

One male pupa of this species measured 20 mm. long and 8 mm. wide. No female pupæ were secured for observation.

Some observations were made upon the change and development of pupæ during the fall of 1909. Some of the larvæ constructed their cavities at the bottom of the jars and next to the sides, which made it comparatively easy to observe their daily changes in appearance. The following notes were secured from a pupa observed at that time:

No. 2884-A. September 23, larva hatched and placed in small jar.
October 3, larva cast first exuvium.
October 16, larva cast second exuvium.
October 23, larva ceased feeding and shortly after that date probably began making cavity. It had made tunnels all through the earth at that time.
October 30, larva pupated in cavity at bottom of jar.
Pupa creamy white and lay on dorsal side. It was observed daily for changes of color, but such changes were very gradual.
November 9, elytra changing to slightly violet color. Eyes could not be plainly seen from the outside. Abdomen still creamy white.
November 12, beetle issued and remained in cavity. Jar filled with earth and transferred to cellar of laboratory where it was allowed to pass the winter. The pupal stage required 13 days in a temperature of from 68° to 75° F.

It is not expected that pupæ mature during the summer in much shorter time than was required in the foregoing experiment, namely, 13 days. In the Southern States, where this species is commonly found, the pupal stage may possibly be two or three days shorter.

BIBLIOGRAPHY.

1775. **Fabricius**, J. C. Systema Entomologiæ, v. 1, 268 p.

Page 239. Contains the original description of the species under the genus Carabus. Habitat, Virginia.

1787. **Fabricius**, J. C. Mantissa Insectorum, t. 1, 348 p.

Page 197. Practically the same description as that in Systema Entomologiæ, 1775.

1792. **Fabricius**, J. C. Entomologia Systematica, t. 1, 538 p.

Page 140. Practically the same description with additions to that in Systema Entomologiæ, 1775.

1795. **Olivier**, A. G. Entomologie ou Histoire Naturelle des Insectes, t. 3, no. 35 (Carabe), p. 42, pl. 3, fig. 31. Paris.

Includes description of species with former references. The author describes it as resembling *Carabus sycophanta* and notes that it was found in North America, in the Carolinas, and in Virginia.

1801. **Fabricius**, J. C. Systema Eleutheratorum, t. 1, 506 p. Kiel.

Page 213. Author's same description of the species but placing it in the genus Calosoma.

1804. **Latreille**, P. A. Histoire Naturelle Générale et Particuliére des Crustacés et des Insectes, t. 8, 411 p.

Page 300. Contains description comparing this species with *Calosoma sycophanta* and notes that it is found in North America.

1815. **Leach**, W. E. The Zoological Miscellany, v. 2, 154 p., 120 pl.

Page 93, pl. 93. Short description of species with figures of adult.

1823. **Say**, Thomas. Descriptions of insects of the families of Carabici and Hydrocanthari inhabiting North America. *In* Trans. Amer. Phil. Soc., n. s., v. 2, no. 1, p. 1–109.

Page 73. Contains a full and very good description of the species.

1826. **DeJean**, le Comte. Species Général des Coléoptères, t. 2, 501 p.

Page 191. Includes a long description of the species as compared with *sycophanta* L., and notes that it is found in North America.

1853. **Chapuis**, F., et **Candeze**, E. Catalogue des Larves des Coléoptères. *In* Mem. Soc. Roy. Sci. Liege, v. 8, p. 347–653, 9 pl.

Page 371. Includes description and figure of larva of *C. scrutator* Fab.

1862. **Rathvon**, S. S. Entomology. *In* Rpt. U. S. Comr. Patents f. 1861, p. 585–620, 90 fig.

Page 592. Noted as a rarer species than *calidum* Fab.

1863. **Harris**, T. W. A Treatise on Some of the Insects Injurious to Vegetation, 640 p., 278 fig., 8 pl.

Page 470. Recorded as eating cankerworms in the grass and on the trees.

1863. **LeConte**, J. L. Notes on the species of Calosoma inhabiting the United States. *In* Proc. Acad. Nat. Sci. Phila. f. 1862, v. 14, p. 52–53.

Synopsis of the species of *Calosoma* occurring in the U. S.

1867. **Glover**, T. Report of the entomologist. *In* Rpt. U. S. Comr. Agr. f. 1866, p. 27–45.

Page 39. Recorded as very useful in destroying cankerworms in orchards in the Eastern States.

1869. **Glover**, T. Food and habits of beetles. *In* Rpt. U. S. Comr. Agr. f. 1868, p. 78–117, 189 fig.

Page 79. Beetles noted as feeding upon caterpillars and climbing trees to obtain them.

1870. **Riley**, C. V. Enemies of the cankerworm. *In* 2nd Ann. Rpt. Noxious, Beneficial, and Other Insects, Missouri, p. 102–103.

Recorded as enemy of cankerworms.

1870. **Riley**, C. V. [Note.] *In* Amer. Ent. and Bot., v. 2, no. 10, p. 306.

Record of a beetle destroying all the caterpillars in a nest in a crab-apple tree, Linwood, Mo.

1870. **Riley**, C. V. The tent-caterpillar of the forest. *In* Amer. Ent. and Bot., v. 2, no. 9, p. 261–266, fig. 165-168.

Page 265. The author writes of the effectiveness of the species of Calosoma, especially *scrutator* Fab., in keeping under control *Clisiocampa sylvatica* Harr.

1873. **Riley**, C. V. Economic Entomology. *In* Trans. Kans. State Bd. Agr. f. 1872, p. 292–325, 19 fig.

Pages 307–308. Includes a note by the author in which he states that he had observed the ground beetles *Calosoma scrutator* Fab. preying upon the worms of *Anisopteryx vernata*.

1878. Riley, C. V. Ground beetles. *In* 1st Rpt. U. S. Ent. Com. f. 1877, p. 313–314, fig. 45–47.

Page 314. Recorded as feeding upon the Rocky Mountain locust.

1879. Williams, J. Beneficial insects. *In* 9th Rpt. Ent. Soc. Ontario f. 1878, p. 36–46, fig. 15–35.

Page 41. Notes to the effect that the beetles are washed ashore on Toronto Island and that they kill cankerworms, army worms, and tent caterpillars.

1880. Comstock, J. H. Report of the entomologist. *In* Rpt. U. S. Comr. Agr. f. 1879, p. 185–347, 16 pl.

Pages 191, 256, and 292. Beetles feed on army worm and *Hibernia tiliaria*. Note to the effect that Coquillett has seen the beetles climbing about in the tops of trees in search of caterpillars of the latter species. Adults also feed on *Aletia argillacea* in Texas. Adults live under sticks, stones, and bark of trees; larvæ in similar places.

1880. Fletcher, J. Entomology for beginners. *In* Canad. Ent., v. 12, no. 1, p. 32–35, fig. 4–5.

Page 35. Common name, "Beautiful-bodied Searcher." Live specimens rare in Toronto.

1880. Riley, C. V. [Note.] *In* Amer. Ent., v. 3 (v. 1, n. s.), no. 9, p. 229.

Known as "Rummaging Calosoma." Beetle taken at Lafayette, Ga.

1881–1884. Bates, H. W. Biologia Centrali-Americana. Insecta Coleoptera, v. 1, pt. 1, 316 p., 13 pl.

Pages 20 and 262. Localities in Mexico where species occur.

1881. Fletcher, J. Popular papers on entomology. *In* 11th Ann. Rpt. Ent. Soc. Ontario f. 1880, p. 19–21, 2 fig.

Page 21. Species rare in Canada; predacious.

1882. Riley, C. V. Report of the entomologist. *In* Rpt. U. S. Comr. Agr. f. 1881–1882, p. 61–214, 20 pl.

Page 99. Record of larvæ of this species feeding upon army worms and attempts at rearing them by L. O. Howard.

1882. Moffatt, J. A. Entomological notes. *In* 12th Ann. Rpt. Ent. Soc. Ontario f. 1881, p. 29–30.

Notes on collection on shore of Long Point.

1883. Forbes, S. A. The food relations of the Carabidæ and Coccinellidæ. *In* Ill. State Lab. Nat. Hist. Bul. 6, p. 33–64.

Page 38. Stomachs of three specimens taken in an orchard infested with cankerworms examined, and the contents were composed of two-thirds insect origin, one-third liquid and unrecognizable.

1883. Howard, L. O. Report of observations upon the army worm, 1881. *In* 3rd Rpt. U. S. Ent. Com., p. 132–135.

Page 135. Larvæ, probably of *scrutator* Fab., found destroying army worms at a great rate. One starved larva killed 15 army worms in 2 hours in confinement, but consumed only 2.

1883. Riley, C. V. Cankerworms. *In* 3rd Rpt. U. S. Ent. Com., p. 157–197, 7 fig.

Page 177. Recorded as preying upon spring cankerworms. Adults climb trees and are taken around tin bands.

1887. Bethune, C. J. S. The cotton moth in Canada. *In* 18th Ann. Rpt. Ent. Soc. Ontario f. 1887, p. 17–18, fig. 1.

An account of the way beetles are blown from fields into lake, then drift ashore after heavy blow.

1890. Bruner, L. Insects Injurious to Young Trees on Tree Claims. Univ. Nebr. Bul. 14 (Bul. Agr. Expt. Sta. Nebr., v. 3), art. 2, p. 83–149, 98 fig.

1890. Packard, A. S. *Cacoecia fervidana* (Clemens). *In* 5th Rpt. U. S. Ent. Com., p. 193–194.

Page 194. Reported attacking *Cacoecia fervidana*.

1894. Leng, C. W., and Beutenmüller, W. Preliminary handbook of the Coleoptera of North Eastern America. *In* Jour. N. Y. Ent. Soc., v. 2, p. 133–141, pl. 3.

Page 140. Brief description of species.

1895. Comstock, J. H., and Anna B. Manual of the Study of Insects. 701 p., 797 fig. Ithaca.

Page 519. Short description and a note on climbing habits.

1895. Fernald, C. H. Entomologist's report. *In* 4th Rpt. Mass. State Bd. Agr. on the work of extermination of the gipsy moth, p. 27–29.

Page 28. Listed as feeding upon the gipsy moth.

1895. Lintner, J. A. List of publications of the entomologist. *In* 10th Rpt. N. Y. State Ent. f. 1894, p. 484–506.

Page 491. Note to the effect that this species closely resembles the European *C. sycophanta* L.

1896. Forbush, E. H., and Fernald, C. H. The Gipsy Moth, Mass State Bd. Agr., 495+c p., 66 pl., 34 fig.

Pages 382–383. Brief notes on the amount of food consumed by the adults in confinement.

1898. Burgess, A. F. Notes on predaceous beetles. *In* 45th Ann. Rpt. Mass. State Bd. Agr. f. 1897, p. 402–411.

Pages 406–407. Brief notes on distribution and attempts at rearing the species.

1899. Gadeau de Kerville, Henri. Description d'un Coléoptère anomal (*Calosoma scrutator* F.). *In* Bul. Soc. Ent. France, p. 81–82.

Page 81. Includes the description of an expansion on the posterior tibia of the right leg of a female specimen from the United States.

1910. Blatchley, W. S. The Coleoptera or Beetles of Indiana. 1386 p., 590 fig. Indianapolis.

Page 47. Occurs in all parts of Indiana and is often attracted by the hundreds to the electric lights of the cities.

1911. Smith, J. B. [Note.] *In* Ann. Ent. Soc. Amer., v. 4, no. 2, p. 179, June.

Note on the presence of *C. scrutator* Fab. and *wilcoxi* Lec. in enormous numbers in southern New Jersey, one year feeding upon a species of geometrid caterpillar, and the following year neither beetles nor caterpillars could be found.

CALOSOMA WILCOXI Lec.

ORIGINAL DESCRIPTION.

Greenish-bronze, blackish-bronze or bronze above, shining with gold and blue below; feet steel-blue; thorax much broader than long, gold-margined; elytra deeply striate, copper margined, spaces between the striæ marked transversely, with punctures marked in triple row. Length 0.77 inch, width 0.4 inch.

Habitat, from New York to Texas, very rare. Very much like the preceding (*scrutator*), but a third smaller, and with thorax a little shorter (and a third narrower), less rounded on the sides behind the middle, slightly retracted; striæ of elytra less deeply but distinctly punctate.

EARLY RECORDS OF THE SPECIES.

This species was originally described by Le Conte in 1848. In his description he mentioned that "it occurs rarely from New York to Texas." In the same year it was listed in his "Descriptive Catalogue of the Geodephagous Coleoptera Inhabiting the United States East of the Rocky Mountains." The description compares this species with *C. scrutator*, which it resembles greatly. In 1862 Le Conte in his "Notes on the species of Calosoma inhabiting the United States" gives descriptive details for separating *wilcoxi* from *scrutator*. The middle tibia of the male of the former species is nearly straight while that of the latter is curved. No published references as to the kind of food sought by these beetles have come to the attention of the writers, save a note by Dr. W. E. Britton, of Connecticut, in his "Tenth Report of the State Entomologist, 1910," in which he states that "Mr. Champlain observed a large ground beetle, *Calosoma wilcoxi* Lec., which was very abundant during the season, feeding upon canker worms."

DISTRIBUTION.

Specimens of this species have been collected in Arkansas, California, Connecticut, Delaware, District of Columbia, Georgia, Illinois, Indiana, Iowa, Kansas, Massachusetts, Michigan, Missouri, Nebraska, New Jersey, New York, Ohio, and Pennsylvania; also in Ontario, Canada. There are records of this species in the Southern States only from Georgia, but it probably occurs in others of them. The collection of the California Agricultural Experiment Station contains specimens from Tulare County of that State, and the species possibly occurs rarely in other far Western States.

COLLECTIONS AND SHIPMENTS.

Entomologists in Washington, D. C., about the last of May and the first of June often observe specimens of *C. wilcoxi* about electric lights in fairly large numbers. Mr. Barber forwarded between May 18 and June 7, 1909, 18 males and 31 females. All were alive except one female. A few other specimens were received from the same source in 1911 and 1912. The writers have been able to secure the data set forth in this paper from the parents collected in 1909.

HABITS OF ADULTS.

The habits of this species in the field are little known to the writers, since they have not had an opportunity to make observations, and the published records are rather fragmentary with reference to this subject. To obtain an idea of their habits two females were placed at the base of the tree (Pl. III) in the climbing experiment, June 14, 1912. Both of these climbed freely and one of the females was found at the top of the test tree the following morning and had consumed two large caterpillars of *Malacosoma americana* that were placed upon it the previous day.

FOOD CONSUMED BY ADULTS.

Of the beetles received in the spring of 1909, five pairs were placed in battery jars and daily records kept of the amount of food eaten. (See Table 6.) The first shipment arrived May 13 and the pairs reserved for feeding and rearing records were offered raw meat for a few days. The beetles partook of this diet rather freely until May 27, when a sufficient number of *M. americana* caterpillars of medium size were secured and substituted.

TABLE 6.—*Feeding records of Calosoma wilcoxi.*

FIVE PAIRS, 1909.

Pair No.	Received from Washington, D.C.	Ceased feeding.	Fifth and sixth stage caterpillars.		Total.
			Malacosoma americana.	*Porthetria dispar.*	
1791	1909. May 18	June 27	67	....	67
1792	18	22	84	....	84
1793	18	24	61	9	70
1794	18	23	66	1	67
1795	18	17	39	1	40

TABLE 6.—*Feeding records of Calosoma wilcoxi*—Continued.

THREE PAIRS, 1910.

Pair No.	Emerged from hibernation.	Ceased feeding.	Fifth and sixth stage caterpillars.		Total.
			Malacosoma americana.	*Porthetria dispar.*	
	1910.				
1791	[1] May 26	July 12	47	17	64
[2] 1792	[2] 23	11	114	17	131
1795	26	11	60	16	76

[1] ♂ Emerged June 4.
[2] June 13 and 22, 4 fertile eggs were deposited.

The records in Table 6 are not normal, as the beetles were received from the South that year. The beetles also ceased feeding early in the season in 1909, as compared with that date for the same beetles in 1910. June 23 was the average date in 1909 and July 11 in 1910. The average number of fifth and sixth stage caterpillars eaten in 1909 was 66, while in 1910 it reached 90, and almost all that were fed in the latter year were in the sixth stage. The average number of large caterpillars consumed by one pair of beetles in two years was 75 each year. There was very little reproduction of this species in confinement, and it is reasonable to expect that they might consume even more food under natural conditions. Ninety caterpillars, such as were fed in Table 6, should equal approximately 250 caterpillars of *Paleacrita vernata* Peck or *Alsophila pometaria* Harr., the latter of which is supposed to form the principal diet of this species in the field. In 1910 the active feeding period of the confined beetles extended over 46 days.

REPRODUCTION.

Close observations were made upon five pairs of beetles received May 18, 1909, through the remainder of the season, but none of this series reproduced that year. Thirteen males and 25 females received somewhat later were placed in a large Riley cage with an ample supply of caterpillars. June 6 one pair was seen in copulation and on June 19 both eggs and larvæ were removed from the cage. Newly hatched larvæ were also found June 20 and 22. Seventeen fertile eggs or larvæ was the total output from the whole supply of beetles in 1909, and these were probably the progeny of the female seen in copulation. One hundred and sixty-four fertile eggs were deposited in 1910 by one or some of the 17 females that emerged from hibernation. The low rate of reproduction, in 1910 at least, was possibly due to the scarcity of males, since only three males lived to emerge from hibernation with the 17 females in the large cage. This does not entirely explain the low egg record secured, as no infertile eggs were found. Females of *C. sycophanta* commonly deposit large numbers of infertile eggs when in confinement without a male, and sometimes do this early in the spring, before their mates have emerged from hibernation.

LONGEVITY OF ADULTS.

Two of the females collected in 1909 died during the spring and summer of 1911. Taking it for granted that they were pupæ in the fall of 1908, they must have spent three years in the adult stage. The males in this same shipment (although they were fewer in number than the females) lived only two years, but under natural conditions they probably live as long as the females, as both sexes of *C. inquisitor* and *C. sycophanta* ordinarily attain approximately the same age before death.

HIBERNATION.

Notes on the hibernating habits of this species are given in Table 7 and the paragraph following.

TABLE 7.—*Showing dates at which Calosoma wilcoxi entered and emerged from hibernation in 1909, 1910, and 1911.*

No.	Date entered, 1909.	Date emerged, 1910.	Depth of cavities, 1910.	Date entered, 1910.	Date emerged, 1911.	Depth of cavities.
			Inches.			*Inches.*
1791	June 27, 1 male, 1 female.	May 26, 1 female.		July 12[1]		
		June 4, 1 male.				
1792	22, 1 male, 1 female.	May 23, 1 male, 1 female.	1½	July 11, 1 male	Male died in cavity.	2
				14, 1 female died.		
1793	24, 1 male	June 18, 1 male[1]		11, 1 male, 1 female.	Female died in cavity.	6
1795	17, 1 male, 1 female.	May 26, 1 male, 1 female.	1	Aug. 3, male died		

[1] Beetles died during the summer.

The average date of entering hibernation in 1909 was June 23 and in 1910 July 11. The depth at which this species hibernated in soft earth ranged from 1 to 6 inches. In 1909 several specimens were placed in a cage in the laboratory yard, but not all of them emerged in 1910. This was not thought to be abnormal at that time, as some ordinarily die during hibernation, but on May 18, 1911, one female emerged from this same cage. (Fig. 5.) This is an instance where one specimen remained in hibernation two winters and one summer.

THE EGG.

Twelve newly deposited eggs were white with a faint yellowish tinge, and averaged 3.9 mm. in length and 2 mm. in width; in form they were elliptical, occasionally somewhat kidney-shaped, and often tapering toward one end.

Most of the eggs were deposited between June 2 and June 22, 1910, and hatched in from 3 to 12 days. The average time passed in this stage by 168 eggs deposited that year was 6.8 days.

BRIEF DESCRIPTION OF LARVA.

First stage.—Form somewhat stout. Average length of 12 specimens, 7.8 mm.; width, 1.8 mm. Caudal appendages of medium length, straight. Color brown above, ventral plates light brown.

Second stage.—Form stouter than in first stage. Average length of six specimens, 12.9 mm.; width, 2.9 mm. Caudal appendages short and stout. Color slightly lighter than in first stage.

Third stage.—Form robust. Average length of six specimens, 22.2 mm.; width, 4.4 mm. Posterior angles of anal segment obtuse, not prominent or protruding backward. Caudal appendages stout at base; dorsal protuberance short, stout, located two-thirds distance from base to tip. Appendages beyond protuberance slender and pointed. Color chestnut brown above. Ventral plates amber. Reddish-brown patch at base of caudal appendages in second and third stages.

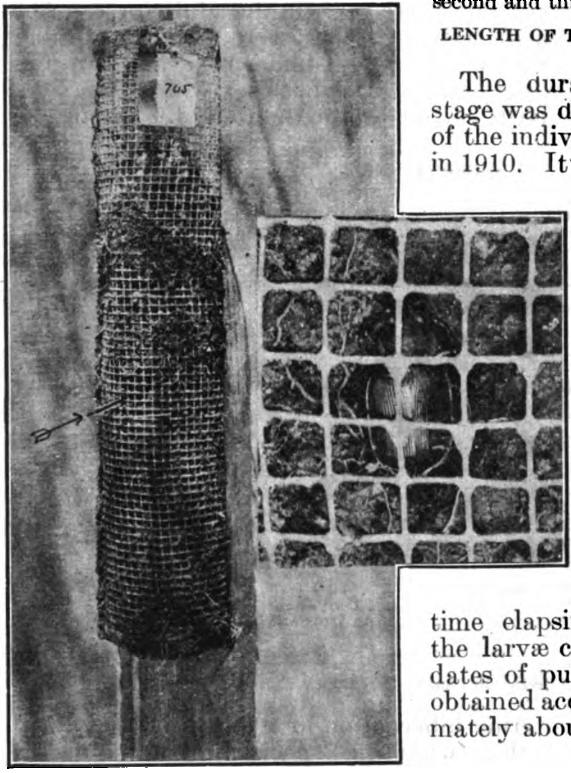


FIG. 5.—Individual hibernation cage that has been removed from the earth. Arrow shows where a Calosoma beetle hibernated; enlargement shows the beetle in the cage. (Burgess.)

LENGTH OF TIME TO COMPLETE LARVAL STAGES.

The duration of each larval stage was determined from a few of the individual records of larvæ in 1910. It was found that the first stage covered on an average 7 days, the second 5, and the third, to the date the larvæ ceased feeding, 14. As is shown in Table 8 the active growing period extends over about 28 days. The larvæ used in these experiments hatched June 9 and were practically full grown about July 5, or 26 days after hatching. The time elapsing between the dates the larvæ ceased feeding and the dates of pupation proper was not obtained accurately, but is approximately about 4 or 5 days.

FOOD CONSUMED BY LARVÆ.

Daily feeding records kept from the date of hatching to the date the larvæ ceased feeding and buried themselves for pupation were as shown in Table 8.

TABLE 8.—*Food eaten by larvæ of Calosoma wilcoxi, 1910.*

No.	Date hatched.	Date ceased feeding.	Sixth-stage caterpillars.		Total.
			Malacosoma americana.	*Porthetria dispar.*	
2778-D	June 9	July 12	3	7	10
2778-E	...do.....	2	7	9	16
2778-F	...do.....	8	2	13	15
2778-G	...do.....	4	3	16	19
2778-H	...do.....	1	8	9	17
2778-J	...do.....	12	8	11	19

Only one of the larvæ in Table 8 lived to pupate, namely, 2778–H. One escaped and the others died after they had become full grown.

The active feeding period of the larvæ was from 22 to 33 days, or an average of 28. The average number of full-grown caterpillars required for the completion of their larval stages was 16, and according to the data obtained they have approximately the same capacity as those of *inquisitor*.

HABITS OF LARVA.

Owing to lack of material no experiments, such as were conducted with *C. calidum*, *C. chinense*, and others have been tried to ascertain whether the larvæ of this species are terrestrial or arboreal in their habits of seeking prey.

THE PUPA.

One female pupa measured 16.5 mm. long and 7.5 mm. wide. No male pupæ were measured.

The one incomplete pupal record secured was from a larva which hatched June 9, 1910, and ceased feeding July 1. On July 14 the pupa was found in a cavity at the bottom of the jar, where it had probably remained eight or nine days, and would have issued in from three to five days more. This pupa was preserved in alcohol, so no adult was secured.

BIBLIOGRAPHY.

1848. LeConte, J. L. A descriptive catalogue of the geodephagous Coleoptera inhabiting the United States east of the Rocky Mountains. *In* Ann. Lyc. Nat. Hist. N. Y., v. 4, p. 173–474, pl. 2.

Page 446. The original description of *Calosoma wilcoxi* Lec.

1863. LeConte, J. L. Notes on the species of Calosoma inhabiting the United States. *In* Proc. Acad. Nat. Sci. Phila. f. 1862, v. 14, p. 52–53.

Synoptic table dividing the various species into groups.

1878. Riley, C. V. Ground beetles. *In* 1st Rpt. U. S. Ent. Com. f. 1877, p. 313–314, fig. 45–47.

Feeds on the Rocky Mountain locust.

1878. LeConte, J. L. Description of a new species of Calosoma. *In* Bul. Brooklyn Ent. Soc., v. 1, no. 8, p. 61–66.

Synoptic table of Calosoma.

1882. Bell, J. T. Entomological papers. *In* 12th Ann. Rpt. Ent. Soc. Ontario f. 1881, p. 27–28.

Page 28. Note on collection on shore of West Lake, Prince Edward County, June 12; 13 specimens taken and 24 on July 1 in another locality.

1883. Riley, C. V. The army worm. *In* 3rd Rpt. U. S. Ent. Com., p. 89–156, ills.

Page 125. Note to the effect that this species feeds upon the army worm.

1894. Harrington, W. H. Annual address of the President. *In* 24th Ann. Rpt. Ent. Soc. Ontario f. 1893, p. 17–31, fig. 9–17.

Page 24. Beetle feeds on cankerworms and is a good climber.

1894. Leng, C. W., and Beutenmüller, W. Preliminary hand-book of the Coleoptera of North Eastern America. *In* Jour. N. Y. Ent. Soc., v. 2, no. 3, p. 133–141, pl. 3.

Page 141. Classification and brief description.

1898. Burgess, A. F. Notes on predaceous beetles, 1897. *In* 45th Ann. Rpt. Mass. State Bd. Agr. f. 1897, p. 402–411.

Page 408. Brief notes on collections and habits.

1910. **Britton, W. E.** Tenth Report of the State Entomologist of Connecticut: *In* Rpt. Com. Agr. Expt. Sta., p. 657-712, fig. 10-23, pl. 25-32.

Page 663. A note on the species feeding upon cankerworms.

1910. **Blatchley, W. S.** The Coleoptera or Beetles of Indiana. 1386 p., 590 fig.

Page 47. Short description with notes on occurrence.

1911. **Smith, J. B.** [Note.] *In* Ann. Ent. Soc. Amer., v. 4, no. 2, p. 179.

Note on the presence of *C. scrutator* Fab. and *C. wilcoxi* Lec. in enormous numbers in southern New Jersey, one year feeding upon a species of geometrid caterpillar, and the following year neither beetles nor caterpillars could be found.

CALOSOMA FRIGIDUM Kirby.

ORIGINAL DESCRIPTION.

Frigid Calosoma, black underneath with greenish sides; elytra furrowed with the furrows punctured; interstices of the furrows elevated with transverse lines impressed, and a triple series of bilobed obscurely gilded punctiform impressions; margin greenish; posterior angles of the prothorax depressed. Length of the body 9½ lines. Taken in Drummond's Island, Canada, by Dr. Bigsby.

Not unlike *C. calidum*, but longer in proportion and more depressed. Body black, not glossy above. Head not confluently punctured and wrinkled; mandibles obliquely but less densely wrinkled, and frontal impressions longer than in *C. calidum;* prothorax scarcely wider than the head, posterior angles bent downward; elytra scarcely at all bronzed, lateral margin obscurely green, with the same number of elevated lines as in *C. calidum* but in the furrows formed by them is a series of punctures, and the transverse lines are less conspicuous; there is a triple series of punctiform impressions, but they are bilobed, smaller, and the gilding is greenish and less conspicuous; they are also less numerous, there being only seven or eight in the series next the suture, eight or nine in the intermediate one, and three only towards the apex in the external one; at the base there is also a pair on each side; the sides of the body underneath are greenish, punctured and wrinkled.

EARLY RECORDS OF THE SPECIES.

The species was first described by Kirby in 1837. Very little further attention was given it until 1848 and 1863, when LeConte included it in his "Descriptive Catalogue and Notes on the Species of Calosoma Inhabiting the United States." This species, like many others of its congeners, often attracts the attention of collectors and is present in most general collections. The senior writer, in 1896, was the first investigator to rear the species successfully through all its stages in confinement, and a continuation of the same work was attempted by himself and the junior writer in 1909 with a fair measure of success.

DISTRIBUTION.

This species occurs in Connecticut, Georgia, Illinois, Indiana, Iowa, Maryland, Massachusetts, Michigan, Minnesota, Nebraska, New Hampshire, New York, Pennsylvania, Texas, and Wisconsin. It also occurs in Ontario and Quebec, Canada. Undoubtedly this species has a greater range than that above mentioned but it is more common in the northern part of the United States and in Canada.

COLLECTIONS AND SHIPMENTS.

From 1909 to 1912 adults and larvæ of this species were collected in the field and brought to the laboratory alive for biologic study.

In 1909 two males and two females were collected near Boston about April 15. Mr. R. Wooldridge stated that he saw three adults on June 18, feeding upon caterpillars of *P. dispar* in Wellesley, Mass.

On July 31 Messrs. Fiske and Burgess, while in Tamworth, Sandwich, and North Conway, N. H., investigating the natural enemies of *Heterocampa guttivitta*, found upwards of 100 beetles in a small infested area, and in one square yard of leaf mold collected 12 second and third stage larvæ of *frigidum*. The latter were fed and reared to maturity at the laboratory.

In 1910, 11 males, 7 females, and 2 larvæ were received, some of which were forwarded by Messrs. P. J. Parrott and H. E. Hodgkiss of Geneva, N. Y. Mr. Parrott collected these beetles at Geneva, Gates, and Seneca Castle, where they were found feeding upon cutworms (*Xylina* sp.). One specimen was taken while feeding upon caterpillars of *Euproctis chrysorrhœa* at Cape Elizabeth, Me.

In the season of 1912, 71 males and 38 females were collected and forwarded to the laboratory between June 1 and June 30. During these years many specimens were seen in the field but were not collected. The adults were frequently taken running up and down the trunks of trees.

HABITS OF ADULTS.

In order to check up the field observations on the climbing habits of this species an experiment was tried with a pair of adults using the apparatus shown in Plate III. The beetles climbed to the top of the tree immediately and with considerable speed. They climbed over the tree at will and were not once seen to fall during the few hours they were left in the experiment. Adults of this species have frequently been reported as fairly common in certain localities in the gipsy-moth infested area, especially under burlaps where they were doing appreciable good in feeding upon the caterpillars. The senior writer [1] found them common in localities in New Hampshire in 1909, where they were observed climbing the trees and feeding freely upon larvæ of *Heterocampa guttivitta*.

All indications point to the fact that the adults of this species find most of their prey on the trees, but the larvæ have very different habits as is pointed out in another part of this paper.

FOOD CONSUMED BY ADULTS.

Feeding records of adults were conducted through 1909, 1910, and 1911, but each year with different pairs, as in all the cases except one the beetles died before a second year's notes could be secured. Caterpillars of *Malacosoma americana* and *Porthetria dispar* were offered for food and the beetles attacked them voraciously. Some of the beetles were collected in eastern Massachusetts and others were reared at the laboratory. The records for 1909 and 1910 are contained in Table 9.

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[1] Burgess, A. F., Notes on *Calosoma frigidum* Kirby, a native beneficial insect. *In* Jour. Econ. Ent., v. 3, no. 2, p. 217-222 (p. 218), 1910.

TABLE 9.—*Feeding records of four pairs of Calosoma frigidum, 1909 and 1910.*

Pair No. and year.	Feeding record started.	Ceased feeding.	Sixth-stage caterpillars.		
			Malacosoma americana.	*Porthetria dispar.*	Total.
2731 (1909)	June 20	Aug. 20	77	153	230
4832 (1910)	2	July 12	92	100	192
4837 (1910)	4	13	35	20	55
4838 (1910)	4	27	51	57	108
Average, 146.					

Some of these beetles died and others entered hibernation at the end of the season.

Pair No. 2731 were collected in eastern Massachusetts during June, 1909, and reproduced in the jar that year. Thirty-seven fertile eggs were deposited by the female—a reason for the large amount of food eaten. None of the other females, all of which were pupæ of the fall of 1909, reproduced, consequently less food was required.

The records in no case were started as soon as the beetles emerged from hibernation, as some were collected in the field and the young stock that emerged in cages were retained until mates could be secured from the field. Unfortunately, record No. 4832, which promised to reach as high a limit as No. 2731, was discontinued a short time before the beetles ceased feeding normally. The beetles consumed from 55 to 230 full-grown caterpillars of *M. americana* and *P. dispar*, or an average of 146 to each pair. This average, without doubt, would have reached approximately 200 caterpillars had all the records been continued through the whole season, and if a larger percentage of the females had been more than one year old.

The beetles referred to in Table 9 emerged from hibernation between May 20 and June 9 and fed as late as August 20, but most of them ceased activity during the latter part of July. The active feeding period, therefore, extends over two to three months.

REPRODUCTION.

Two pairs of beetles confined in jars in 1909 were kept under observation for reproduction. One pair produced 37 eggs between June 21 and June 30. They were seen in copulation on June 24, 27, and 29, and died August 30 and 31 of that year, after having consumed 230 full-grown caterpillars of *Malacosoma americana* and *Porthetria dispar*.

In 1910 six pairs were confined in jars but only one pair reproduced. The female deposited eggs June 28 and 29, but only two hatched. In these experiments were one male and four females that were reared at the laboratory in 1909, and one of the females, which was paired with a male collected during the spring, deposited eggs.

One pair of the beetles (pupæ of the summer of 1909) lived until July 6, 1911, but did not reproduce in 1910 or 1911, nor were they seen in copulation either year.

During the year 1911 five pairs of beetles were under observation for reproduction. None of these were seen in copulation and only one of the five females reproduced. This was one of those collected during the spring and it deposited 12 fertile eggs.

One pair of beetles collected June 1 and 7, 1912, was placed immediately in a jar for rearing records. The female began oviposition June 8 and continued until June 23. One hundred and thirty fertile eggs were deposited and the female died July 2.

Thirteen pairs of beetles were confined in jars at the laboratory during 1909, 1910, and 1911, and only three pairs reproduced. Fifty-one fertile eggs was the total number secured, or an average of 17 to each female that deposited. In 1896[1] the senior author kept one female in confinement that produced 186 fertile eggs in one season. It is probable that most of the beetles collected during the spring and confined at the laboratory were young stock. It has been demonstrated and published in Bulletin 101 of the Bureau of Entomology that *Calosoma sycophanta* reproduces very sparingly during the first year, and the same is evidently true of *C. frigidum*. From four first-year females of the latter species in confinement during 1910 only two fertile eggs were secured.

LONGEVITY.

One pair of adults were collected in eastern Massachusetts about June 15, 1909. The male died September 2, 1910, and the female some time later during the same hibernation period. Another male collected in the spring of 1910 lived until June 21, 1911. The latter male was paired in a jar with a young female which was a pupa of the summer of 1909. The young female lived just one year in the adult stage. Another pair of beetles were pupæ of the summer of 1909. The male died during the hibernation of 1910–11, but the female lived until July 6, 1911. None of the beetles cited in the above instances reproduced while in captivity.

Those beetles that were collected in the field during the spring were probably pupæ the previous summer. On this basis the first pair of beetles cited lived one or two months over two years. The one which lived longest of any reared at the laboratory was a female, which remained alive for about two years. The available records do not show that this species lives longer than two years, but it is probable that it lives at least three years in the field.

HIBERNATION.

From the small collection of larvæ brought from New Hampshire August 1, 1909, five adults were reared. The larvæ ceased feeding between August 9 and 13 and then burrowed into the earth in the cages, where they constructed cavities for pupation. Four of the cavities formed were from 1 to 2½ inches below the surface, while one specimen was found 6 inches below. One female emerged May 20, 1910, three females May 26, and one male was dug up June 4. Two other pairs entered hibernation July 18 and 27, 1910, respectively. One female lived to emerge June 1, 1911, and one male was dug up June 7. They hibernated ¾ to 2 inches below the surface.

The average date that old beetles entered hibernation in the summer of 1910 was July 29, but young adults, which do not breed, may enter at a much earlier date. The notes also show that emergence took place in eastern Massachusetts from May 20 to June 7, and that the average depth at which the beetles hibernated was 2 inches.

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[1] Burgess, A. F. Notes on certain Coleoptera known to attack the gipsy moth. *In* 44th Ann. Rpt. Mass. State Bd. Agr. f. 1896, p. 412–431 (p. 419), pl. 3–5.

EXPORTATIONS.

June 17, 1912, 10 males and 10 females were packed with damp sphagnum moss singly in pill boxes, which were inclosed in a larger box and forwarded by mail to Mr. E. M. Ehrhorn, superintendent of entomology, in the Hawaiian Islands. The adults were fresh specimens, collected in the field just previous to the date of shipment. Mr. Ehrhorn wrote that only two males and three females arrived alive, but that those were very active. It was rather difficult to explain the reason for the death of so many individuals, as the moss in the boxes was still damp on receipt.

Cutworms had been reported as numerous and destructive in the islands by Mr. Ehrhorn, and it was thought desirable to attempt to introduce this species and *C. calidum* to prey upon these noxious pests.

THE EGG.

Fourteen fresh eggs gave the following average measurements: Length, 4 mm.; width, 1.7 mm. They are yellowish-white, somewhat elliptical in form, and taper slightly toward one end.

The eggs are deposited singly in the earth and hatch in from 4 to 10 days, depending mainly upon the temperature. Two hundred and sixteen eggs deposited in 1912 by several females between June 8 and 19 hatched, on an average, in about six days.

DESCRIPTION OF LARVA.

The following description of the larval stages was made in 1896 by the senior author:[1]

First larval stage.—At the time of hatching the young larva is of the same color as the egg, but gradually grows darker, until in about 10 hours it is of a deep shining brown. After remaining in the cavity occupied by the egg for about twenty-four hours, the larva comes to the surface of the ground in search of food. At this time the length is 8 mm., including the caudal appendages, which measure 1 mm.; the width at the middle of the first thoracic segment is 1.7 mm., from which point the body tapers gradually to the last segment. The head is large in proportion to the body, longer than wide, somewhat flattened, and truncate behind. The clypeus is separated from the epicranium by a well-defined suture, which extends to the base of the antennæ, dividing the raised portions from which they arise. The front edge of the clypeus is emarginate, and bears a prominent hair at each anterior angle. There are also three pairs of hairs situated on the forward part of the clypeus and two pairs directly between the eyes, one pair being on the clypeus and one on the epicranium. Antennæ setaceous, four jointed and ferruginous. Eyes conspicuous, and situated in groups of six each, on slight elevations just behind the antennæ. The mandibles are dark brown in color, long, simple, stout at base, but quite pointed at the tip, the left mandible often folded over the right. The maxillæ and labium are small, ferruginous and provided with well-developed palpi. Prothorax large, as long as the meso- and meta-thorax, slightly contracted and rounded posteriorly. Mesothorax slightly rounded posteriorly; metathorax truncate. Lateral edges of the body segments slightly produced. Dorsal line prominent on all the segments except the last. On the dorsum of each thoracic segment there are ten short hairs, one on the anterior part of each lateral margin, one at each angle of the segment and one on each side of the dorsal line at the anterior and posterior margins. Abdominal segments, nine in number, with the exception of the last, truncate behind, the last segment

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[1] Burgess, A. F. Notes on certain Coleoptera known to attack the gipsy moth. *In* 44th Ann. Rpt. Mass. State Bd. Agr. f. 1896, p. 412-431, pl. 3-5.

being rounded posteriorly and bearing a pair of caudal appendages. Each segment except the last bears six hairs, one on each lateral margin and two on each side of the dorsal line at the posterior margin. The last abdominal segment bears a pair of hairs on each lateral margin, but none on the dorsum. The caudal appendages are entire, although probably jointed at the base, and bear numerous hairs. The spiracles are situated just below the dorsal plates. The ventral portion of the body is of a yellowish white except the portions which are strengthened by chitinous plates. These are of the same color as the dorsal part of the body. Legs well-developed, provided with stout spines which are especially prominent at the joints, the tarsi bearing two claws. The last body segment bears on the posterior ventral portion an appendage which serves as a proleg and aids in locomotion. The larva remains in this stage about four days. Molting is accomplished by a splitting of the thoracic plates along the dorsal line; the head, mouth parts and legs are then withdrawn and the exuviæ forced back over the posterior end of the body. The newly molted larva is of a pale straw color.

Second stage.—Length, 15 mm.; width, 3 mm. Form somewhat stouter than in the preceding stage. Head relatively smaller, flattened, as wide as long; eyes less prominent. Clypeus deeply emarginate in front and feebly incised at the middle. Antennæ and mouth parts relatively the same as in the last stage; the body, however, is of a somewhat paler brown color. All the body segments except the last are truncate behind, and bear a well-defined dorsal line. The first thoracic segment is broadest posteriorly and gradually narrows toward the head, but is not quite as wide as the two succeeding segments. The hairs are arranged the same as in the first stage, except that two pairs of hairs arise on the lateral edges of each segment up to the last, which bears only one pair. The caudal appendages are entire but not quite as prominent as in the previous stage, and the legs are a little more slender. The time spent in this stage varies from four to eleven days.

Third stage.—After molting the larva measures 22 mm. in length and 4 mm. in width, and is of a light mahogany-brown color, which soon changes to a dark seal brown. The mandibles are stout, and bear a prominent carina. The clypeus is deeply bilobed in front, the hinder border separated from the epicranium by a somewhat indistinct suture. Prothorax narrowed in front and much wider behind. Caudal appendages each provided with a blunt spine, which is thickened at the base and arises from the dorsal surface. When full grown the larva is very stout, and measures 32 mm. in length, and 6 mm. in width. A detailed description of the full-grown larva follows:

The head is of medium size, slightly flattened and of the same color as the body. Clypeus somewhat shield shaped. A faint line separates the clypeus from the epicranium and reaches to the base of the mandibles, but does not divide the raised portions which bear the antennæ. Front edge of clypeus strongly bilobed, each anterior angle bearing a prominent spine; top of the clypeus slightly hollowed toward the dorsal line. The spines are the same in number and arrangement as in the previous stages. Eyes near base of antennæ, not prominent. The antennæ are setaceous, short, four-jointed, and arise from an elevation at the base of the mandibles. First joint short, cylindrical and naked; second joint nearly twice as long, slightly clavate and bearing a short hair near the middle of the outer margin; third joint a little shorter than the second, somewhat clavate and having one anterior angle slightly produced, and bearing three spines, which arise near the outer angles; last joint as long as the first, nearly cylindrical and bearing three spines at the apex. Mandibles large, stout at base, with a prominent dorsal carina. A strong, simple, blunt tooth arises near the base. The mandible gradually tapers from the outermost insertion of this tooth to a somewhat chisel-shaped point. The maxillæ are small, ferruginous in color, and are densely covered with hairs and spines. They bear four-jointed, naked palpi, which are nearly as long as the antennæ. The three inner segments of the maxillary palpus are short, stout, truncate, and of nearly equal length; the terminal joint is slightly longer than the two preceding joints, oblong ovate in form and truncate at the tip. The galea or inner lobe is naked, two-jointed and as long as the three basal joints of the palpus. Lacinia prominent and bearing a spine at its apex. Labium small, somewhat halberd shaped, with numerous spines arranged in an oval row on the inner side. Palpi two-jointed; outer joint the longer and truncate at tip.

The dorsal thoracic plates are large, and nearly cover the lateral thoracic walls, while the dorsal abdominal plates, with the exception of the last, are smaller, and allow the lateral walls of the abdomen to protrude. Dorsal line not prominent. Each abdominal plate except the last bears, near the posterior margin, a very feeble transverse carina. Spines are arranged as in the preceding stage. The last segment is relatively small, nearly truncate behind: the caudal appendages of moderate length, and each bears on the upper surface a large, blunt, hornlike protuberance, which is terminated with a bristle. Numerous other hairs occur on these caudal appendages. The ventral portion of the body is yellowish white except the parts which are strengthened by chitinous plates.

Spiracles seal brown, nine on each side, borne in shallow depressions just below the lateral edges of the dorsal plate, on the mesothorax and on each abdominal segment except the last. Those on the abdominal segments are small and circular, while the thoracic spiracles are decidedly larger and elliptical in outline. Legs small, very muscular and spiny. Coxæ very stout, dark brown; trochanters, femora and tibiæ slender, reddish brown; tarsi of same color, one jointed and bearing two simple claws. The anal proleg is slender, tapering and bears a number of short spines. This appendage serves the double function of acting as an organ of locomotion and also containing the cavity into which the rectum discharges. General color of under surface sordid white, varying to light gray, variously marked with light seal-brown patches. Head and anterior part of prothorax seal brown. Two lateral rows of elongated markings of similar color extend along the body beneath the spiracles. The upper row terminates on the penultimate segment, the lower row on the last segment.

The markings forming the upper row are single and entire on the first two thoracic segments; on the metathorax there are two spots, the anterior being the smaller. On the abdominal segments the markings are somewhat circular, two to each segment, a large orbicular marking being followed posteriorly by a smaller one of similar shape. The markings composing the lower row are in general elliptical, and occur singly on the segments stated. On both the meso- and meta-thorax there is a single small brown spot on the median line. In a corresponding position on each of the following segments except the last two, and near the anterior margin, there is a large elliptical, transverse, seal-brown spot. Posterior to this marking on each of the segments mentioned there is a transverse row of four small spots of similar color. On the last two segments the median spot is quite large and somewhat pentagonal in outline. The transverse row of small spots occurring on the preceding segments is here absent.

The full-grown specimen measured and referred to in the foregoing description was probably abnormally large, as those measured recently do not exceed 30 mm. in length. Larvæ in this stage have a reddish-brown patch at the base of the caudal appendages.

THE PUPA.

Following is a description of the pupa:

Length, 18 mm.; width at first abdominal segment, 6.4 mm. Oblong, somewhat elliptical and flattened. General color of the body pale amber. Head medium, somewhat flattened in front and strongly depressed beneath the thoracic segments. Eyes prominent, seal brown in color. Antennæ and mouth parts free, translucent. Prothorax broader than long, considerably narrowed behind; mesothorax emarginate in front and two-thirds as long as the metathorax; all separated by well-defined sutures. Wing covers translucent and extending beyond the third abdominal segment. Abdominal segments nine in number, the sides of the body protruding beyond the dorsal portions. The lateral edges of abdominal segments 2 to 6 produced to a blunt point, within which is a slight depression. Penultimate segment slightly depressed; last segment greatly depressed beneath the body, and bearing on the posterior margin a pair of small anal stylets. Each of the first five abdominal segments bears a narrow brush of erect brown hairs, which extends two-thirds of the distance across the segment. The nine pairs of spiracles are light chestnut brown, and are situated in the same relative position as those of the larva; they are larger, however, and elliptical in outline, those on the metathorax being the largest. Legs free, translucent, and nearly surrounded by the wing covers.

Although a few adults were reared from larvæ in 1909, no specific data were secured on the exact time passed in the pupal stage. August 2 one full-grown third-stage larva was collected in New Hampshire and fed until August 9. August 13 it was transferred to a small fly-screen cage, which was set in the ground, and allowed to bury up for pupation. October 4 the cage was removed and a young living female was found in a cavity 6 inches below the surface. The female was replaced in the same cage in a cavity 2 inches below the surface and reset in the ground. May 26, 1910, the female emerged from the latter cavity.

Other full-grown larvæ were placed in similar cages about the same time and were not disturbed, but allowed to emerge normally the following spring. One specimen was unearthed in the fall to make sure that this species does not hibernate in the larval or pupal stages. None of the adults reared in 1909 emerged from its cavity as soon as transformation from the pupa took place, as did *C. calidum*. The time spent in this stage varies, being apparently from 10 to 14 days.

TIME REQUIRED TO COMPLETE LARVAL STAGES.

Data secured from larvæ in 1909 showed that the first stage covers a period of from 2 to 5 days or an average of 4; the second an average of 5, and the third 11. The total number of days the larvæ are active and feed is 20, after which time they burrow into the earth and form the pupal chamber. The time required for this is practically the same as with other species of the genus studied.

FOOD CONSUMED BY LARVÆ.

Mention has previously been made concerning the feeding of the larvæ upon the larvæ and pupæ of *H. guttivitta* in New Hampshire. Some larvæ were brought in from the field in second and third stages and fed to maturity on caterpillars of *Porthetria dispar*. A few others that hatched from eggs deposited in breeding jars were fed until they reached the third stage, when all died, and combinations were thus compiled from these.

The data obtained from feeding records of these larvæ are given in Table 10.

TABLE 10.—*Food eaten by larvæ of Calosoma frigidum, 1909.*

No. of larva.	*Malacosoma americana and Porthetria dispar* fourth and sixth stage caterpillars eaten during first larval stage.	*Porthetria dispar.*		Total.
		Sixth-stage caterpillars eaten during second larval stage.	Sixth-stage caterpillars eaten during third larval stage.	
2731-A	2	6		
2765-A			9	17
2731-E	3			
2765-B		4	13	20
2731-H	3	4		
2765-E			11	18

The average number of large-sized caterpillars, mostly sixth-stage *Porthetria dispar*, consumed by a single larva from hatching to maturity was 19, or approximately the same number as was destroyed by larvæ of *C. wilcoxi* or *C. inquisitor*. Had caterpillars of *Heterocampa guttivitta*, which are much smaller, been used, the number destroyed would undoubtedly have reached 25 or 30. June 23 and 28 were the dates of hatching of some of the larvæ, and they continued their activity in and out of the earth in jars for about 20 days.

Two larvæ that hatched June 24, 1912, were fed almost to maturity and died July 10 and 11, respectively. They were supplied chiefly with pupæ of *Porthetria dispar,* but at the beginning caterpillars of *Malacosoma americana* were offered. Six caterpillars and 8 pupæ were consumed by the first larva and 4 caterpillars and 10 pupæ by the second.

Data secured in New Hampshire in 1909 and 1910 on the feeding habits of the larvæ upon *Heterocampa guttivitta* indicated that the pupal stage of the latter species furnished the most victims of attack. The larvæ of *frigidum* were approaching maturity at the time most of the caterpillars of *Heterocampa guttivitta* had entered the pupal stage in cells under leaf mold. In these cavities the larvæ of *frigidum* devoured large numbers of them.

HABITS OF THE LARVÆ.

June 21, 1911, five larvæ, which hatched June 20, and some of which had fed a little, were tested as to their ability to climb. (Pl. III.) Three of them, when placed upon the bark of the tree, clung to it for a short interval, then crawled into crevices and remained there. The other two repeatedly fell from the bark as soon as placed upon it. At 9 a. m., when the experiment was started, caterpillars were left in a cage at the top of the tree for food. At noon all the larvæ were on the ground, running around the circle and attempting to climb up the tin in an endeavor to escape. On the morning of June 22 four of the larvæ were found in the earth in the circle, but there was no evidence of any having entered the food cage during the night. Two of the larvæ were again placed upon the bark of the tree, but fell each time without climbing. On June 23 there was no evidence that the larvæ had entered the food cage since the preceding day. June 24 one first-stage larva was again placed upon the tree, but it showed very little inclination to climb, each time hiding under the loose scales of the bark and immediately falling when forced to crawl from under them. June 25 only two first-stage larvæ could be found, after examination of all the earth, and one of these was very weak from approaching starvation. Neither had entered the food cage over night. June 26 one of the larvæ that was found in the circle the preceding day was dead and the other was almost dead. June 27 one other first-stage larva was found in the earth at the base of the tree, having been overlooked in the search of the two previous days. It was also very weak and was removed and placed in a jar of earth and fed, but died later, presumably from the prolonged starvation.

Two were lost during the experiment and it is quite probable that they were devoured by their mates, for the latter lived about six days without other food. A further test was made with larvæ of this species in all stages between June 26 and July 6, 1912. They were left inside the circle during this time with food in the cage at the top of the tree but they did not climb there to secure it. They were removed and fed when starvation seemed imminent, or lepidopterous pupæ were left on the surface of the earth in the circle for a brief period. They were many times placed upon the bark of the tree but did not crawl in any case more than 6 inches before falling. Three inches upward was the best progress noted.

The data at hand is rather conclusive that these larvæ seemed to search for their food in, on, or near the ground. Starvation resulted if the food supply was elsewhere.

Starvation, and to a slight extent cannibalism, among the larvæ is, in the writers' opinion, almost totally responsible for the nonincrease of the species in the areas infested by the gipsy moth and brown-tail moth. From the data at hand it also seems probable that *frigidum* does not reproduce as abundantly as some of the other species investgated.

In the gipsy moth infested area the beetle larvæ occasionally find stray caterpillars crawling upon the ground, but these, on the whole, are scarce except in cases where woodland is being stripped and caterpillars are migrating in search of food. The writers have not heard or noted *C. frigidum* as numerous in the area above mentioned as they were in the White Mountain region of New Hampshire in 1909,[1] when *Heterocampa guttivitta* defoliated large areas of beech, maple, and other woodland growth and when 87 per cent of the pupæ were destroyed by larvæ of *frigidum* in a single year. The caterpillars of *Heterocampa guttivitta* furnish more food for *frigidum* larvæ than those of *Porthetria dispar* and *Euproctis chrysorrhœa*, because the former usually fall or descend to the ground during their feeding stages. Hence, the species, as a whole, fares much better in a locality where *Heterocampa guttivitta* or other lepidopterous insects that pupate on the ground are present than where caterpillars or pupæ are present that remain in the trees. This, it is believed, explains why *C. frigidum* has not increased rapidly and become an important factor in destroying the gipsy and brown-tail moths.

BIBLIOGRAPHY.

1837. Kirby, W. Fauna Boreali-Americana, Pt. IV. Insects. 325+xxxix p., 8 pl.

Page 19. Original description of the species.

1863. LeConte, J. L. Notes on the species of Calosoma inhabiting the United States. *In* Proc. Acad. Nat. Sci. Phila. f. 1862, v. 14, p. 52–53.

Classification of the various species into groups.

1870. Kirby, W. Insects of the Northern Parts of British America. *In* Canad. Ent., v. 2, no. 7, p. 89–93.

Page 89. Comparison of *calidum* Fab. with *frigidum* Kirby.

1878. LeConte, J. L. Description of a new species of Calosoma. *In* Bul. Brooklyn Ent. Soc., v. 1, no. 8, p. 61–66.

Pages 64, 65. Synoptic table of Calosoma.

1882. Bell, J. T. Entomological papers. *In* 12th Ann. Rpt. Ent. Soc. Ontario f. 1881, p. 27–28.

Page 28. Notes on collection of adults from West Lake, Prince Edward County.

1894. Harrington, W. H. Annual address of the President. *In* 24th Ann. Rpt. Ent. Soc. Ontario f. 1893, p. 17–31, fig. 9–17.

Page 24. Notes to the effect that this species feeds upon cankerworms, also climbs well.

1894. Leng, C. W., and Beutenmüller, W. Preliminary handbook of the Coleoptera of Northeastern America. *In* Jour. N. Y. Ent. Soc., v. 2, no. 3, p. 133–141, pl. 3.

Page 140. Synoptical table of Calosoma of North Eastern United States.

1896. Bowditch, F. C. List of Mount Washington Coleoptera. *In* Psyche, v. 7, Supplement II, 11 p.

Species taken in July at summit of Mount Washington.

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[1] Burgess, A. F. Notes on *Calosoma frigidum* Kirby, a native beneficial insect. *In* Jour. Econ. Ent., v. 3, p. 217–222.

1896. Forbush, E. H., and Fernald, C. H. The Gipsy Moth. Mass. Bd. Agr., 495+c p., 66 pl., 34 fig.

Page 383. Brief account of its feeding habits.

1897. Burgess, A. F. Notes on certain Coleoptera known to attack the gipsy moth. *In* 44th Ann. Rpt. Mass. State Bd. Agr. f. 1896, p. 412–431, pl. 3–5.

Page 418. Full life-history notes with descriptions of the different stages.

1898. Burgess, A. F. Notes on predaceous beetles, 1897. *In* 45th Ann. Rpt. Mass. State Bd. Agr. f. 1897, p. 402–411.

Page 406. Contains notes on reproduction and field observations.

1908. Patch, Edith M. The Saddled Prominent, *Heterocampa guttivitta* Walker. Maine Agr. Expt. Sta. Bul. 161, p. 309–350, fig. 14–40.

Brief notes on the abundance of adults and larvæ which were preying upon the above lepidopterous pest.

1910. Blatchley, W. S. The Coleoptera or Beetles of Indiana. 1386 p., 590 fig.

Page 47. Brief description and notes on occurrence.

1910. Burgess, A. F. Notes on *Calosoma frigidum* Kirby, a native beneficial insect. *In* Jour. Econ. Ent., v. 3, p. 217–222.

Notes on the abundance of the species in the White Mountains, N. H., where there were outbreaks of *Heterocampa guttivitta*. It was found on August 21–25, 1909, that an average of 54 per cent of the pupæ had been destroyed by *frigidum* larvæ, and they were still present and feeding.

1910. Fiske, W. F., and Burgess, A. F. The natural control of *Heterocampa guttivitta*. *In* Jour. Econ. Ent., v. 3, no. 5, p. 389–394.

Contains notes and tables to the effect that 87 per cent of the *Heterocampa guttivitta* pupæ in localities of the White Mountain region were destroyed by *frigidum* larvæ during August, 1909, and that 3.66 per cent died from the attack of parasites or from other causes.

CALOSOMA INQUISITOR (L.).

ORIGINAL DESCRIPTION.

[Translation.]

Elytra striate, greenish-bronze: punctures in triple row.

Roland act. Stockls. 1750, p. 292, t. 7, f. 3. Carabus, winged, greenish-coppery, punctate and striate concavely, feet and antennae black.

Habitat in trees of Europe, living on larvæ of *Papilio* and *Phalaenalis*.

Elytra golden, with green margin. Thorax very short.

EARLY RECORDS OF THE SPECIES.

This very interesting species was described by Linnaeus in 1758 as *Carabus inquisitor*. Since that time it has attracted the attention of many prominent European entomologists, judging from the many short and unique accounts written about it. Linnæus, in 1758 and 1761, gave its habitat as Europe, destroying larvæ of Papilio and Phalænalis in trees. Paykull, in 1790, gave a lengthy and comprehensive description, giving the habitat as forests and gardens. Panzer, in J. G. Voet's "Beschreibungen und Abbildungen Hartschaaligter Insekten," Col. Tab. 38, fig. 39, 1793, presents a life-size colored figure of the adult. Description and references to the species are made in 1795 by Olivier, who says that "* * * it is found ordinarily on trees, principally oaks, where it catches different insects on which it is nourished."

Geoffroy, in 1799, lists what is undoubtedly this species under Buprestis; and Fabricius, in 1801, the year that Friedrich Weber established the genus Calosoma, placed this species under the latter genus. Thomas Marsham, in 1802, lists this species as *Buprestis sycophanta minor*, and P. A. Latreille, in 1804, included it under Calosoma, where it has remained until the present time. Latreille reported it as being found about Paris but less commonly than *C. sycophanta* L.

Dejean, in 1826, reported the species common in Germany and northern Europe but more rare in France. J. T. Dawson, in 1854, stated that the species occurred on oaks in different localities in England and Ireland. The following reference is quoted from J. T. Harris, published in 1865–66.[1]

> Occurrence of *Calosoma inquisitor* near Burton-on-Trent. In a woodland near here I was fortunate enough, early in June last, to take about 30 specimens of this insect and could have taken more. I found several in the sunshine and also, just at dark, moving about freely on the stems of the oak trees but did not observe many during the daytime high up on the branches, as described by Mr. F. Plant in "The Zoologist" some years back. J. T. Harris, 31 Lichfield St., Burton-on-Trent, July 3, 1865.

The larva of this species was first described in 1867 by J. C. Schiodte in his remarkable work, "De Metamorphosi Eleutheratorum Observationes."

C. Houlbert and E. Monnot, in 1905, published on the species, describing the adult and giving a short description of the larva. They named many localities in central France where the species is known to occur.

IMPORTATIONS.

All importations of this species in 1906 were forwarded by Miss Marie Ruhl, Zurich, Switzerland. The exact localities in Europe where collections were made could not be ascertained, as the specimens were forwarded to her, then repacked and shipped to the gipsy moth parasite laboratory.

TABLE 11.—*Importations of Calosoma inquisitor from 1906 to 1910.*

Year.	Number living.	Received dead.
1906	280	170
1907	....	....
1908	1	....
1909	91	4
1910	143	36
Total	515	210

The mortality during transit was much greater in 1906 than in later years. A change in methods of packing and shipping gave better results. Most of the living specimens were liberated very soon after receipt but a few were kept for cage and jar records in order that closer observations might be made.

HABITS OF ADULTS.

Experiments showed that these beetles are very agile on the trees and that they prefer running up and down the trees rather than remaining on the ground. Their favorite hiding place is in the crotches of trees. These observations bear out those of J. T. Harris in 1864–65, which are quoted in another part of this paper. This species has habits similar to *C. frigidum* in all stages. The adults of both species intuitively search for their prey in trees, finding caterpillars that feed upon the foliage.

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[1] See Bibliography, p. 63.

Undoubtedly adults of this species fly, but this has not been positively proved. A few attempts to induce them to do so were made in 1911, by tossing specimens in the air, but all the beetles dropped heavily to the ground without spreading their wings. This same sort of treatment of *sycophanta* by the junior author resulted in the escape of a few specimens, these skimming gracefully out of sight.

FOOD CONSUMED BY ADULTS.

The capacity for consumption of food by this species is much less than that of the larger species, such as *scrutator* and *sycophanta*. The feeding records of four pairs are given in Table 12.

TABLE 12.—*Feeding records of 4 pairs of Calosoma inquisitor, 1910.*

Pair No.	Emerged from hibernation.	Ceased feeding.	Fifth and sixth stage caterpillars.			
			Noctua clandestina.	*Malacosoma americana.*	*Porthetria dispar.*	Total.
2706	May 24	July 7	....	112	8	120
2720	20, 24	19	....	68	13	81
2721 [1]	17	19	10	124	9	143
2722	24	13	....	61	6	67

[1] Female reproduced in June.

The average number of large caterpillars consumed by each pair of beetles in 1909 and 1911 was 50 per year, but this record is too low, as the experiments were not started until about June 10.

The records secured in 1910 (Table 12) were normal and were kept consecutively from the date of emergence in the spring to the date the beetles entered hibernation. Each pair destroyed on an average 103 large caterpillars of *Malacosoma americana* or *Porthetria dispar*.

REPRODUCTION.

The first living adults of this species were imported from Europe in 1906, but the few attempts made at rearing the species at that time were unsuccessful.

June 7, 1909, many living specimens were received, and several pairs were placed in battery jars for rearing and feeding records, but no eggs were deposited during that year. In 1910 one female out of 13, of which close records were kept, oviposited, and this female was received from Europe in 1909. Seventy-nine eggs were deposited between May 24 and June 10, 1910, which is the largest record for any female of this species in a single year.

One female of the importation of 1909 that did not reproduce that year or the following deposited 23 fertile eggs between June 1 and June 27, 1911, and died July 3. A few other females received in 1910 did not reproduce that year, but did so in 1911.

After reading these notes one can perhaps appreciate the many disappointments experienced in rearing predacious beetles. Frequently there was no reproduction from females for two successive years.

LONGEVITY OF ADULTS.

July 8, 1908, one female was received from Europe, and in the fall of that year was placed in a hibernation cage in the laboratory yard. There were no males to pair with this female until 1909. As soon as a shipment was received a mate was given her. The female lived to enter hibernation in the fall of 1910, but in the spring of 1911 no trace of her could be found in the cage. The adult mentioned was a larva in the summer of 1907 or earlier, and therefore lived at least three years in the adult stage. This female did not reproduce.

One pair of beetles, No. 2720, received from Europe on June 7, 1909, lived until July 3, 1911, when both died. At the time they died the weather was very hot, the temperature in the jars reaching 107° F. several times. The female produced 79 fertile eggs in 1910, but none in 1909 or 1911. These beetles must have been in their first year when received in 1909, thereby living two winters and three summers after reaching Massachusetts. Another female in the same shipment lived until July 5, 1911, and did not reproduce during three years. The original mate of this female, received at the same time, lived two winters and two summers to date of entering hibernation in 1910. Still another female with an interesting record was received from Europe on the same date as the preceding, and lived to enter hibernation in the late summer of 1911. The mates of this female died each summer, and although she was each time supplied with another she failed to reproduce. This female died in hibernation during the winter of 1911–12, having lived more than three years.

HIBERNATION OF ADULTS.

Close observations were made on a series of breeders in 1909, 1910, and 1911 to obtain the exact dates of their entering and emerging from hibernation. This varies in different years and with beetles of different ages, as will be shown by Table 13.

TABLE 13.—*Showing date of entering and emerging from hibernation of Calosoma inquisitor during 1909, 1910, and 1911.*

No.	Sex.	Date entered, 1909.	Date emerged, 1910.	Depth of cavity, 1910.	Date entered, 1910.	Date emerged, 1911.	Depth of cavity, 1911.
				Inches.			*Inches.*
2706	Male	June 28	May 24	1	July 7	(1)	(2)
	Female	do	do	(3)	do	(4)	
2720	Male	June 24	May 20	(3)	July 19	May 15	1½
	Female	do	May 24	1	do	do	2
2721	Male	July 8	May 17	(3)	do	do	1
	Female	do	do	(3)	do	do	1
2722	Male	June 20	May 24	1	July 13	(4)	
	Female	do	do	1	do	June 5[6]	4
2723	Male	June 25	June 16[5]	6	July 2		(3)
	Female	do	do[6]	16	do	May 27	(3)

[1] Died in hibernation.
[2] On surface.
[3] Unknown.
[4] Missing.
[5] Dead.
[6] Alive; cages dug up before beetles emerged.

The date of entering hibernation in Table 13 is the time the beetles ceased feeding and made cavities in the bottom of the breeding jars. The beetles were transferred from these to hibernation cages as soon as possible, and in each case they were obliged to construct another cavity. One will note from the table that the beetles ceased feeding to enter hibernation earlier in 1909 than in 1910, the average date being June 27 in the former year, and July 12 in the latter. Only one of the females (No. 2723) lived to enter hibernation in the fall of 1911 and this one died before the following spring. All the original males and females in this series, except female No. 2706, which was received in 1908, were received from Europe in the spring of 1909. Some of the males died later but were replaced with males from more recent shipments. These beetles may have been collected in Europe in a locality where spring opens at an earlier date than in New England, and as a consequence their active feeding season was cut short in 1909. The records of 1910 appear more nearly normal. The writers suspect that female No. 2723, whose cage was dug up June 16, 1910, disclosing the beetle at a depth of 16 inches, might have remained dormant through that summer until the next spring had she not been disturbed at that time. The junior author discovered in 1911 that this habit is peculiar to a portion of *sycophanta*, which gives reason for suspicion that this and other species of the genus may have the same habit.

The depths of the cavities of this species range from 1 to 16 inches but most of them were found from 1 to 4 inches below the surface.

COLONIES.

Most of the beetles imported were liberated in suitable localities soon after receipt; a very few of this species were kept for study. In all, five separate colonies have been liberated since 1906. On June 20 of that year Mr. E. S. G. Titus and Mr. F. H. Mosher liberated 80 specimens in woodland which was badly infested by the gipsy moth in Lynnfield, Mass. On the same date another colony of 87 specimens was placed in the same town about a mile from the first liberation, and on July 7, 20 specimens were released a short distance from the point where the last-mentioned planting was made. These colonies were visited several times during the summer of 1906, but no beetles or larvæ were recovered. In 1908 a number of trees in the center of each of these colonies were burlapped and several examinations were made during the summer, but none of the beetles or their larvæ were found. Numerous examinations have been made since that time with similar results.

On June 15, 1909, 27 males and 45 females were released in badly infested woodland in Melrose, Mass., and although several careful examinations were made that year and in the years following the species has not been recovered. On June 26, 1911, nine second-stage larvæ of this species that had been reared at the laboratory were placed in a cultivated field in Saugus, Mass., where cutworms were abundant. At that time it was anticipated that more *inquisitor* larvæ could be added to this colony, but owing to a heavy mortality in the rearing jars it was impossible to do this. It was desired to see if it was not possible for this species, particularly the larvæ, to develop if liberated in surroundings where caterpillars which were terrestrial in habit were within easy reach. Although several examinations have been made, no living specimens of *inquisitor* have been recovered in this or in the other colonies that have been liberated. It is probable that the failure of the beetle larvæ to climb explains in part the inability of the species to become established in this country. It will be noted that no large colonies were liberated, and this may have made it more difficult for the species to propagate and develop. Apparently *inquisitor* is not as hardy a species as *sycophanta* or the species of Calosoma native to New England. At any rate the chances of it having become established in this country are very small.

THE EGG.

The egg is yellowish-white, elliptical, usually tapering toward one end. Twelve fresh eggs gave the following average measurements: Length, 4.3 mm.; width, 2.4 mm.

Seventy-nine eggs were deposited by one female between May 24 and June 10, 1911, and these required an average of 9.6 days to hatch. Seventy-one eggs were deposited by six females in 1911 between June 1 and June 27 and averaged 6⅕ days in the egg stage. The difference in time noted above was due to the temperature, as high temperature favors rapid hatching.

BRIEF DESCRIPTION OF LARVA.

First stage.—Color brownish-black above, ventral plates, brownish-gray. Form slender. Average length of 12 specimens, 8.9 mm.; width, 2.3 mm. Caudal appendages of medium length, rather slender.

Second stage.—Color brown to dark brown above; ventral plates chestnut brown. More slender than first stage. Average length of 12 specimens, 12.6 mm.; width, 2.9 mm. Caudal appendages stouter but no longer than in first stage.

Third stage.—Body more robust than in previous stages. Average length of 12 specimens, 21 mm.; width, 4.5 mm. Posterior angles of anal segment acute and extending backward rather prominently. Caudal appendage stout, almost straight; dorsal protuberance prominent, erect, located about two-thirds distance from base to tip. Color same as in second stage. A reddish-brown patch at base of caudal appendages in second and third stages.

LENGTH OF TIME REQUIRED TO COMPLETE LARVAL STAGES.

Observations were made on 14 larvæ during the summer of 1910 to determine the length of time passed in each stage. The average for the first stage was 8.6, for the second 6.6, and for the third 8.7 days to the date the larvæ ceased feeding. Twenty-four days covered the active growing period of the larvæ. The time passed in the first stage may appear somewhat long as compared with records of other species, but the weather was cool during the first part of June and retarded the growth and activity of the larvæ.

FOOD CONSUMED BY LARVÆ.

Twenty-two feeding experiments with larvæ were started in individual jars during the summer of 1910 and from these 14 complete records were secured, as shown in Table 14.

TABLE 14.—*Food eaten by larvæ of Calosoma inquisitor, 1910.*

No.	Date hatched.	*Malacosoma americana* caterpillars eaten, fourth to sixth stages.	*Porthetria dispar* caterpillars eaten, fourth to sixth stages.	Total.	No.	Date hatched.	*Malacosoma americana* caterpillars eaten, fourth to sixth stages.	*Porthetria dispar* caterpillars eaten, fourth to sixth stages.	Total.
2721-A [1]	June 1	5	18	23	2721-M	June 3	5	16	21
2721-B	1	5	7	12	2721-P	4	4	8	12
2721-C	1	6	7	13	2721-Q	4	4	4	8
2721-E	1	2	10	12	2721-R	5	4	14	18
2721-F	3	8	6	14	2721-S	5	10	13	23
2721-G	3	7	7	14	2721-U	5	5	8	13
2721-I	3	7	19	26	2721-V [1]	6	8	9	17

[1] Full-grown larvæ died.

Twelve larvæ in Table 14 lived to pupate and two died when full grown. The average date that the larvæ hatched was June 4, and the average date they ceased feeding June 30, so that the active feeding and growing period extended over 26 days. The average number of fourth to sixth stage caterpillars of *Malacosoma americana* and *Porthetria dispar* caterpillars required by each larva to complete its growth was 16.

HABITS OF THE LARVÆ.

Several larvæ were tested as to their inclination and ability to climb trees in search of food. (Pl. III.)

June 9, 1911, three larvæ less than 24 hours old were placed on the surface of the earth within the tin circle. Two of the larvæ were repeatedly placed upon the bark of the tree, where they crawled for one or two minutes, in and out of the smallest crevices, and then fell to the ground. They did not climb as much as 2 inches either up or down the tree before falling.

The experiments were continued until June 30 with first and second stage larvæ and observations made once or twice each day. The larvæ in neither of the two stages were observed at any time attempting to climb on their own initiative. There was no evidence of their ever having entered the food cage during the continuation of the experiment. No third-stage larvæ were tested on account of lack of specimens.

This species in all stages has habits very similar to *C. frigidum*. The adults of the latter are commonly found upon trees whereas no reports have come to us of their larvæ having been taken in such situations. Some bibliographical references and notes made at the laboratory indicate that adults of *C. inquisitor* climb for their food while their larvæ search for it at or near the ground.

THE PUPA.

One female pupa measured 15 mm. in length and 7 mm. in width, and 2 females averaged 15.8 mm. in length and 7.3 mm. in width.

Out of 22 feeding records kept in 1910, 7 of the larvæ after they ceased feeding were obliging enough to make cavities for pupation at the bottom or side of the jars. This made it possible to make notes on their transformations without disturbing them. In some cases the prepupæ were removed from their cavities and placed upon the surface of the earth where their metamorphoses could be observed more easily. Table 15 gives an idea of the dates of the changes from larvæ to pupæ and the issuance of adults.

TABLE 15.—*Date of hatching and transformations of larvæ and pupæ of Calosoma inquisitor, 1910.*

No.	Date eggs hatched.	Date larvæ ceased feeding.	Date pupated.	Sex.	Date adults issued.	In pupal stage.
	1910.					*Days.*
2721-C	June 1	June 24	(1)	Female.	July 14	(1)
2721-E	1	27	(1)	Female.	19	(1)
2721-G [2]	3	30	July 3	Female.	12	9
2721-M	3	July 6	(1)	Female.	22	(1)
2721-P	4	June 29	July 3	Male.	16	(1)
2721-R	5	...do.....	4	Female.	15	11
2721-U	5	June 28	8	Male.	21	13

[1] Not known.

[2] Pupated on surface of earth in jar.

In the foregoing records the date on which the larvæ ceased feeding and adults issued is given in each case. In three of the records the date the larvæ pupated was ascertained. Six days is the average time between the dates feeding ceased and pupation took place; hence if 6 days is added to the date on which feeding ceased in cases marked "not known" in Table 15, the date of pupation will be indicated. After averaging the records in the table in the above-mentioned manner it is found that 6 days are required for constructing a cavity and preparing for pupation and 12 days are spent in the pupal stage.

STARVATION EXPERIMENT CONDUCTED IN 1911.

May 27, 1911, a pair of beetles emerged from hibernation and were placed in a jar of earth without food to ascertain how long they would live. The female died June 8 and the male June 18. The former lived 12 and the latter 22 days without food after emerging from hibernation.

A male reared in 1910 emerged from hibernation May 25, 1911, and was placed in a jar without food. This specimen lived until June 2, or 8 days after emergence.

It is very evident that beetles less than 1 year old require food sooner than older specimens. The experiment indicates that *inquisitor* can not survive as long without food as its congener *sycophanta*, a detailed account of which is given in Bulletin 101 of the Bureau of Entomology.

BIBLIOGRAPHY.

1758. LINNÆUS, C. Systema Naturæ, ed. 10, t. 1, 826 p. Leipsic.

Page 414. Contains the original description of the species, under the genus Carabus; gives its habitat as Europe, states that it feeds upon larvæ of Papilio and Phalaenalis.

1761. LINNÆUS, C. Fauna Svecica, ed. 2, 578 p. (no. 789). Stockholm.

1767. LINNÆUS, C. Systema Naturæ, ed. 12 rev., t. 1, pt. 2, p. 533–1327.

Page 669, No. 11. Same as original description.

1775. FABRICIUS, J. C. Systema Entomologiæ, v. 1, 268 p.

Page 239. Short description giving habitat as Europe.

1776. MÜLLER, O. F. Zoologiæ Danicæ Prodromus seu Animalium Daniæ et Norvegiæ Indigenarum. 282 p. (p. 77, no. 835).

1787. FABRICIUS, J. C. Mantissa Insectorum, t. 1, 348 p. (p. 197, no. 31).

1790. PAYKULL, G. von. Monographia Caraborum Sveciæ. 138 p.

Page 65, No. 39. Full description of the species with good notes as to its habitat. The author reports finding it in forests, but twice as abundant in the Carlbergian garden, under stones and decayed leaves toward the end of the month of May.

1792. FABRICIUS, J. C. Entomologia Systematica, t. 1, 538 p. Hafniæ.

Page 149. Short description with biographical references.

1793. VOET, J. E. Beschreibungen und Abbildungen hartschaaligter Insekten, Coleoptera, Linn., von G. W. F. Panzer. 5 pt., 48 pl.

Contains many references and a short description of the species, which is referred to as "Der Raupenjager" (The caterpillar hunter) (p. 86, no. 39, pl. 38, fig. 39).

1795. OLIVIER, A. G. Entomologie, ou Histoire Naturelle des Insectes, t. 3, no. 35 (Carabe), p. 42, pl. 3, fig. 31. Paris.

Short description comparing it with *Carabus vagans*, also list of references. The author reports that it is ordinarily found upon trees, mainly oaks, where it catches different insects upon which it is nourished.

1798. PAYKULL, G. von. Fauna Svecica, t. 1, 234 p.

Page 127. References and description with the same notes as to its habitat, cited in his Monographia Caraborum.

1799 **Geoffroy**, E. L. Histoire Abrégée des Insectes, t. 1, 556 p., 10 pl. Paris.

Page 145, No. 6. The species is here described under the genus Buprestis. All previous references list it under Carabus.

1801. **Fabricius**, J. C. Systema Eleutheratorum, t. 1, 506 p. Kiel.

Page 212, No. 7. The species is here placed in the genus Calosoma for the first time after the establishment of the new genus by Weber.

1802. **Marsham**, T. Entomologia Britannica, t. 1, 547 p.

Page 448, No. 40. Described and listed as *Buprestis sycophanta minor*. "Habitat in forests, army of insects running over green twigs by night."

1804. **Latreille**, P. A. Histoire Naturelle Générale et Particulière des Crustacés et des Insectes, t. 8, 411 p.

Page 299. This author again places the species in the genus Calosoma where it has remained since that date. "It is found in the vicinity of Paris, but is less common than *Calosoma sycophanta*."

1810. **Gyllenhal**, Leonardo. Insecta Svecica, t. 1, pt. 2, 660 p. Scaris.

Page 50, No. 2. Long description of species with references and notes as to habitat. "Habitat in shady gardens, forests, under stones, and here and there under fallen leaves."

1826. **DeJean**, le Comte. Species Général des Coléoptères, t. 2, 501 p.

Description, comparing this species with *C. sycophanta;* also some notes on a variety of *C. inquisitor, C. cupreum.*

1846. **Kirby**, W., and **Spence**, W. An Introduction to Entomology.

Page 454. Recorded as a pursuer and enemy of *Brachinus crepitans.*

1854. **Dawson**, J. F. Geodephaga Britannica. A Monograph of the Carnivorous Ground-beetles Indigenous to the British Isles. xx+224 p., 3 pl. London.

Page 42. Description with notes on its occurrence in localities of Britain.

1865–1866. **Harris**, J. T. Calosoma inquisitor near Burton-on-Trent. *In* Ent. Mo. Mag., v. 2, p. 64; same *in* Entomologist, v. 2, p. 321.

1867. **Schiödte**, J. C. De Metamorphosi Eleutheratorum Observationes, Bidrag til Insekternes Udviklingshistoire. *In* Naturlh. Tidskr., ser. 3, v. 4, p. 415–552, pl. 12–22.

Pages 482–483. Includes full description of larva, and a note of its habitat. This is the first description of the larva so far as known.

1905–1907. **Houlbert**, C., et **Monnot**, E. Coléoptères, Carabides. *In* Trav. Sci. Univ. Rennes, Fauna Ent. Americaine, t. 1, pt. 2, p. 289–379, fig. 68–145.

Page 291. Includes figure and description of the species, also many localities in France where it has been reported.

CALOSOMA SAYI Dej.

(Syn.: *Calosoma armatum* Lap.)

ORIGINAL DESCRIPTION.

[Translation.]

Length 25 mm. Eastern and Southern States. Obscurely coppery above; elytra crenately striate; interstices equal, grooved transversely, punctures impressed, coppery-gold and longer than wide, raised, somewhat smooth, in triple row; intermediate tibiæ curved.

DISTRIBUTION.

This insect is represented in collections from Alabama, Arkansas, California, District of Columbia, Florida, Georgia, Illinois, Iowa, Kansas, Louisiana, Maryland, Missouri, New Jersey, New York, North Carolina, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, and Virginia. It is also known to occur in Mexico.

COLLECTIONS AND SHIPMENTS.

Through the efforts of Prof. C. E. Sanborn, Stillwater, Okla., Mr. H. P. Loding, Mobile, Ala., and Mr. H. S. Barber of the Bureau of Entomology, the following living specimens of *Calosoma sayi* were received:

TABLE 16.—*Specimens of Calosoma sayi received in 1910 and 1912.*

Date received.	Number of specimens.		Locality in which collected.	Collector.
	Male.	Female.		
May 26, 1910	....	1	Washington, D. C....	H. S. Barber.
June 19. 1910	1	....	Stillwater, Okla......	C. E. Sanborn.
July 12, 1910	1	[1] 2	Mobile, Ala..........	H. P. Loding.
July 14, 1910	4	2	Mobile, Ala..........	H. P. Loding.
May 28, 1910	....	1	Washington, D. C....	H. S. Barber.
Total....	6	6		

[1] One female was dead on receipt.

Mr. H. P. Loding, Mobile, Ala., under date of April 8, 1910, wrote the senior author the following concerning this species:

> Our most common Calosoma is *C. sayi* Dej., which occurs here in some numbers during the latter part of July. This insect is found frequently around electric lights in the city and I have also found it preying upon caterpillars of various species on low shrubbery and herbage.

This gives an idea of the occurrence and habits of the species in that section.

FOOD CONSUMED BY ADULTS.

Only a few feeding records were attempted and these are incomplete because many of the beetles died. A male received from Washington, D. C., May 26, and a female from Oklahoma, June 19, 1910, were fed in a jar from June 20 until July 21 and 23, when both died. One hundred and twenty-three full-grown caterpillars of *Malacosoma americana* and *Porthetria dispar* were consumed by the pair during the month they lived.

One female received from Washington, D. C., May 28, 1912, was fed in a jar until it sought hibernation August 30. Seventy-two caterpillars of *Malacosoma americana*, *M. disstria*, *Porthetria dispar*, and *Estigmene acraea*, ranging from fourth to sixth stage, were consumed. No eggs were deposited by this female and no male was available for a mate.

REARING AND HIBERNATION RECORDS, 1910–1912.

All the beetles received in 1910 were paired in jars, but neither copulation nor deposition of eggs followed, and all died at the end of that season. Only one female was received in 1912. As no males of this species were available, three males of *C. calidum* were placed in the jar with the female between June 8 and 13, but neither copulation nor reproduction ensued. The female was put into a hibernation cage August 30 and died late in the fall.

BIBLIOGRAPHY.

1826. **DEJEAN**, le Comte. Species Général des Coléoptères, t. 2, 501 p.
Page 198. Original description of the species.

1831. **DEJEAN**, le Comte. Species Général des Coléoptères, t. 5, 883 p.
Page 558. Short note on the arching of the mesothoracic legs of the male.

1877. **POPENOE**, E. A. A list of Kansas Coleoptera. *In* Trans. Kansas Acad. Sci. f. 1876, v. 5, p. 21–40.
Page 22. Listed as rare in eastern Kansas.

1881-1884. Bates, H. W. Biologia Centrali-Americana. Insecta Coleoptera, v. 1, pt. 1, 316 p., 13 pl.

Pages 21, 262. This species believed by Mr. Gehin, according to Mr. Flohr, to be the same as *C. armatum* Lap.

1885. Riley, C. V. Coleoptera, or beetles which destroy *Aletia*. *In* 4th Rpt. U. S. Ent. Com., p. 95-97, figs. 14-16.

Page 95. Feeds on the cotton worm (*Aletia argillacea*), p. 95.

CALOSOMA SYCOPHANTA (L.).

[Pl. I.]

ORIGINAL DESCRIPTION.

[Translation.]

Gold-shining, thorax dark blue, elytra golden green, striate, abdomen somewhat black.

Habitat in Europe.

This is the largest species of the genus in Europe. The head and antennæ are black; the margins of the thorax and elytra golden. The elytra have 15 crenate striæ.

This insect was described by Linnæus. It is found more or less commonly in almost all European countries, especially in localities where lepidopterous larvæ are abundant, and is considered one of the most useful species of this genus on account of its ability to climb trees and its capacity for destroying caterpillars and pupæ.

HABITS OF ADULTS.

Extensive investigations have been carried on at the gipsy moth parasite laboratory, and careful studies have been made to secure all the information possible concerning the life history and habits of this species.[1]

Two important facts have recently been secured, namely, that the beetles may live four or more years, this having been determined by records secured from specimens reared at the laboratory and kept under observation for that period. It has also been determined that the beetles sometimes, and possibly quite frequently, enter hibernation and do not emerge until the second spring thereafter. Several careful records showing this peculiar habit have been obtained in the course of the investigation of this species.

DESCRIPTION OF LARVA.

First stage (Pl. X, *A*, *B*).—Average length of 12 newly-hatched specimens, from base of mandibles to posterior end of last abdominal segment (not including anal proleg or caudal appendages), 9.3 mm.; average width at mesothoracic segment, 2 mm.

The anal proleg is usually 1 mm. in length and the caudal appendages are about twice as long and taper gradually to the tips.

Color jet-black above; legs, antennæ, and mouthparts dark mahogany brown. If placed under a lens the body appears very dark brown, and the legs and mouthparts are of a somewhat lighter shade. Joints of antennæ, palpi, legs, and underside of body of a pearly color, except chitinous markings, which are jet-black. General outline of body fusiform. Antennæ longer than mandibles; maxillary palpi nearly as long as antennæ, tapering to tip of last joint; labial palpi stout, last segment cylindrical, truncate; prothorax wider than long. Second abdominal segment as wide as the first, body tapering quite abruptly beyond the 5th abdominal segment. Body

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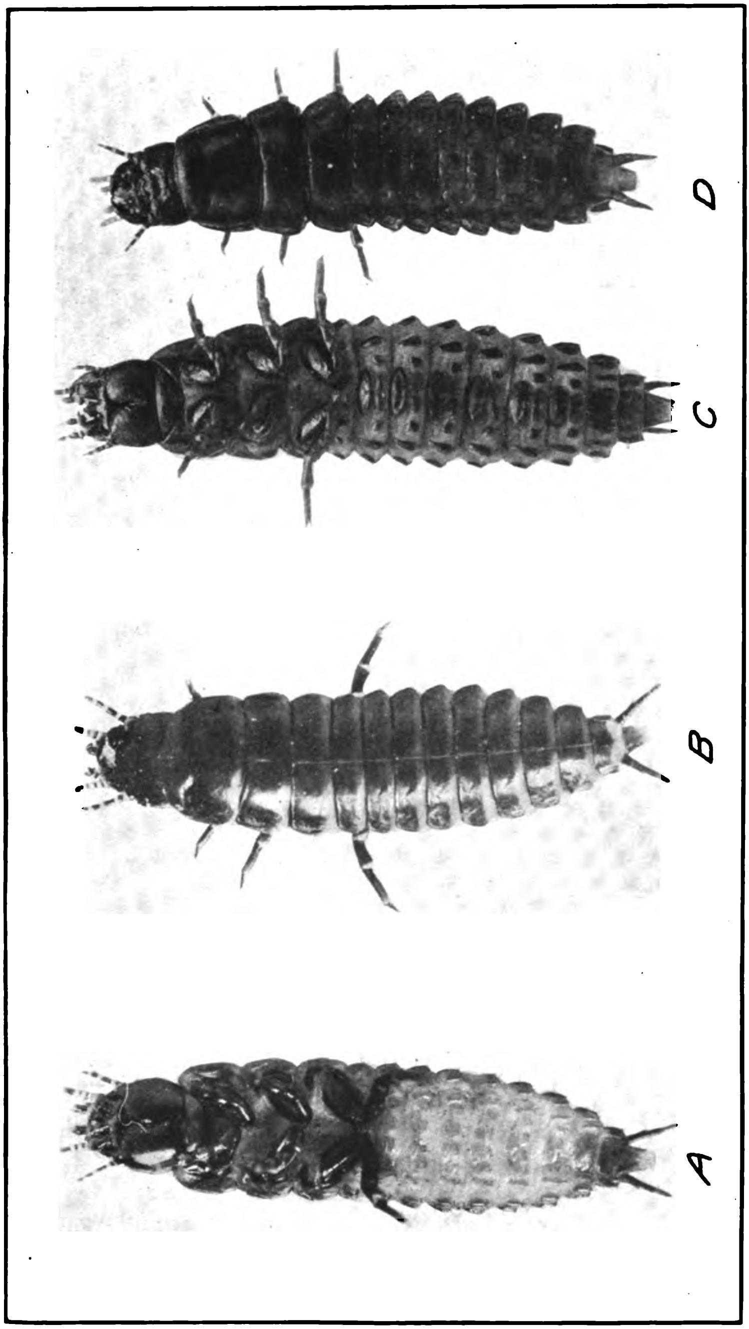
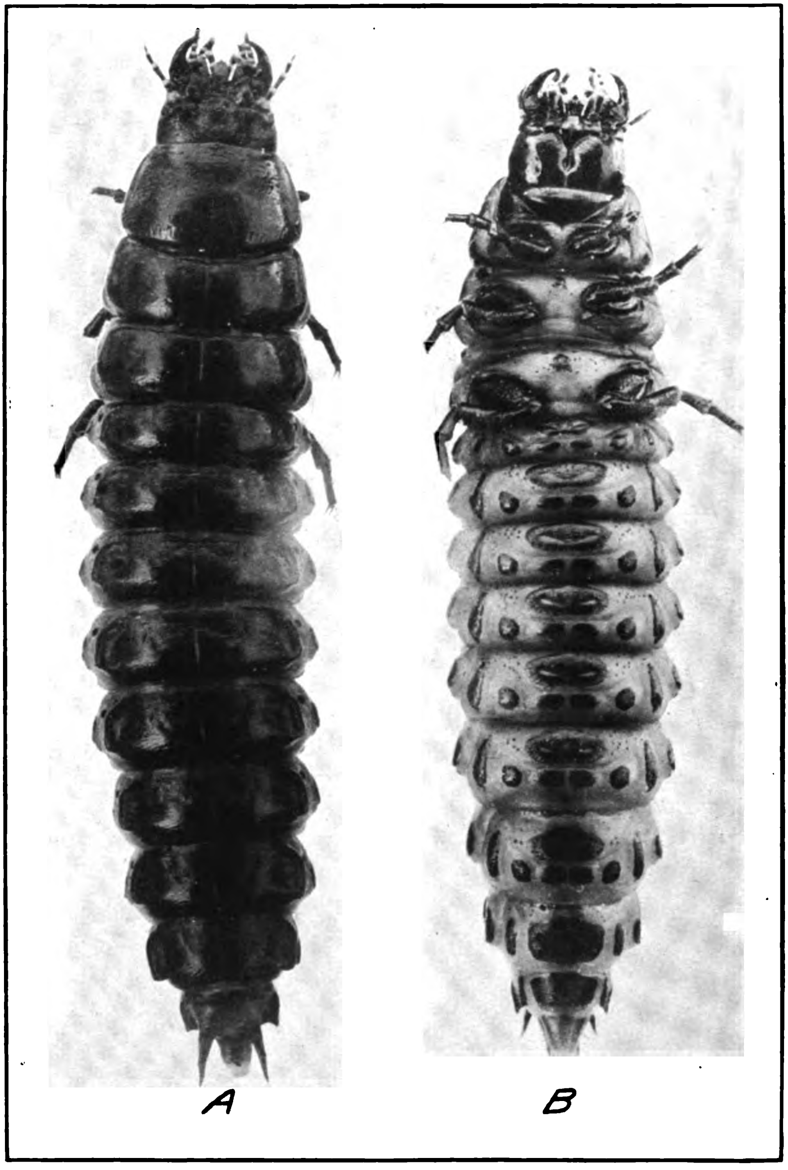
[1] Most of the information obtained has already been published in Bulletin 101 of the Bureau of Entomology, and the reader is referred to this publication for the principal details of this insect. (See also Bulletin No. 251, U. S. Department of Agriculture.)



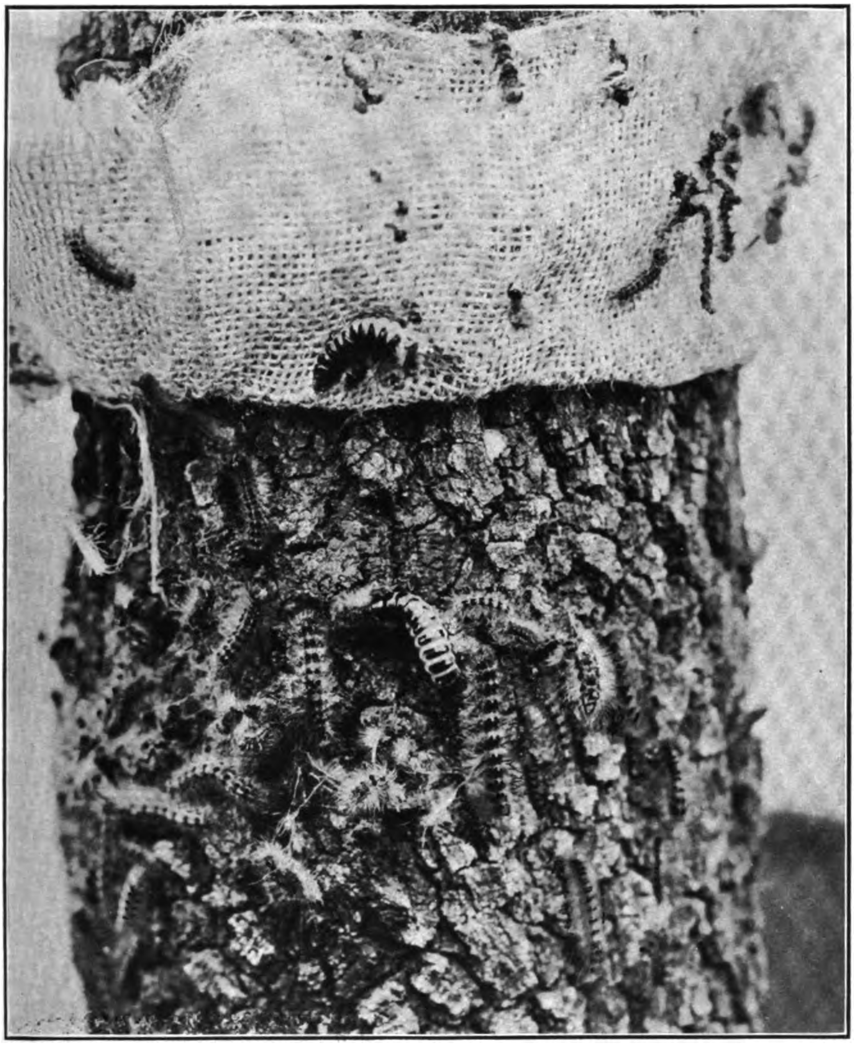
CALOSOMA SYCOPHANTA.

A.—First-stage larva, ventral view, ×6. *B.*—Same, dorsal view, ×6. *C.*—Second-stage larva, ventral view, ×4. *D.*—Same, dorsal view, ×4. (Original.)



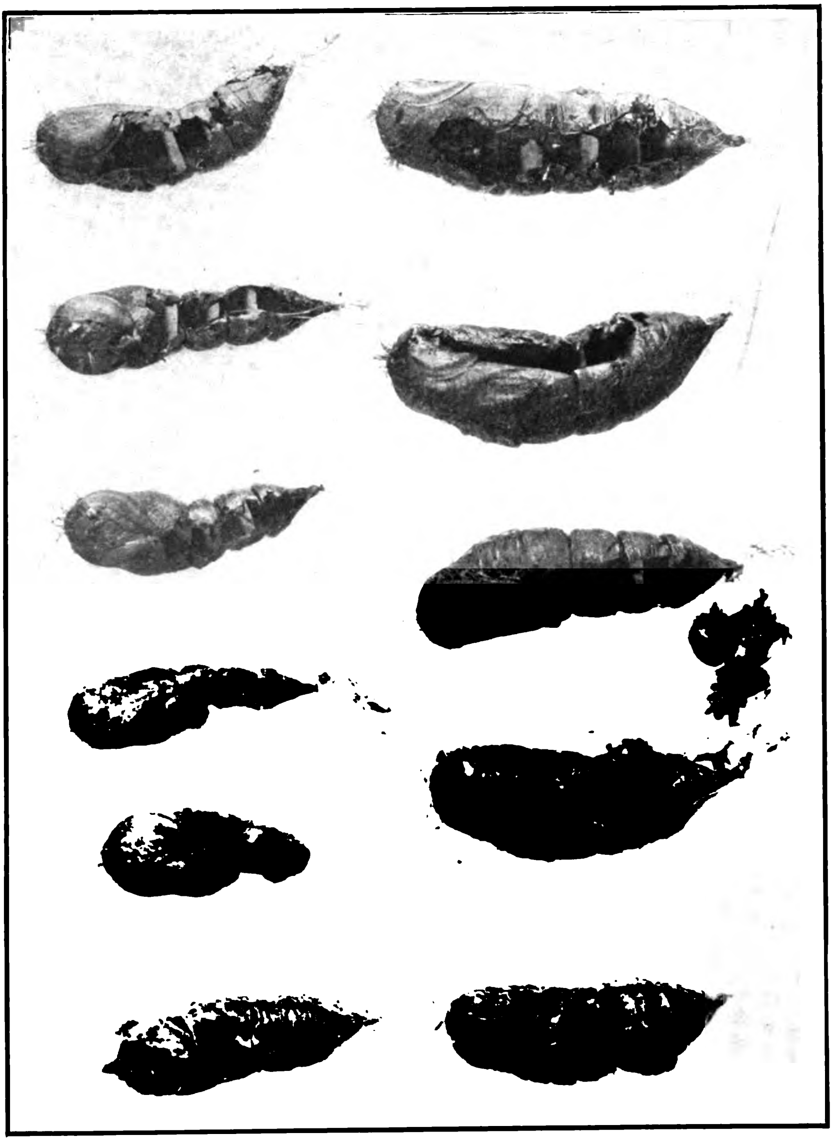
CALOSOMA SYCOPHANTA.

A.—Third-stage larva, dorsal view, X4. *B*.—Same, ventral view, X4. (Original.)



CALOSOMA SYCOPHANTA.

Larvæ of *Calosoma sycophanta* feeding on gipsy-moth caterpillars under burlap which has been turned up. (Burgess.)



BENEFICIAL WORK OF CALOSOMA SYCOPHANTA.

Pupæ of the gipsy moth that have been destroyed by the larvæ of *Calosoma sycophanta.* Note the irregular holes, which are characteristic. (Burgess.)

provided with rows of lateral and ventral spines. Legs spiny. Caudal appendages bearing a few spines.

Second stage (Pl. X, *C*, *D*).—Average length, 15.5 mm.; average width, 3.4 mm. Much stouter than first-stage larva. Body shining jet-black, mandibles and legs mahogany brown, mouthparts lighter, nearly honey yellow, dorsum of last abdominal segment and tip of proleg light brown. Caudal appendages relatively shorter than in preceding stage, each provided dorsally with a stout but short protuberance on its inner third, which bears a stout bristle.

Third stage (Pl. XI, *A*, *B*).—More robust than in previous stage. Average length, 25.8 mm.; average width, 5.7 mm. Body shining black in color; mandibles, legs, mouthparts, antennæ, and lateral and ventral abdominal markings dark brown. Prothorax much wider than long, wider behind. Dorsum of last abdominal segment and anal proleg chestnut brown. Dorsal abdominal plates nearly truncate behind; lateral margins of each raised and thickened, these margins more prominent on the last three segments. On the penultimate segment each dorso-lateral margin forms a stout, blunt, overhanging fold, while on the last segment each margin is drawn out into a stout tooth, pointing backward.

Median dorsal line prominent on all segments, except the last. Caudal appendages short, quite erect, with a large, stout, dorsal tooth, and a small lateral tooth, both of which are provided with spines.

HABITS OF LARVÆ.

The larvæ of this species are able to climb trees and are particularly successful in doing so on species that are provided with rough bark. All the larval stages of this beetle climb skillfully and feed upon caterpillars or pupæ that are resting on the bark (Pl. XII). Lepidopterous pupæ are especially favored as food by these larvæ, and as the gipsy moth is in the pupal stage during the time these larvæ are abundant in the field, the predacious larvæ are particularly adapted to destroy them. (Pl. XIII.)

DESCRIPTION OF PUPA.

Length, 25 mm.; width at first abdominal segment, 12 mm. Color pale yellow. Head depressed, only a small portion of the pronotum being visible from above. Dorsal part of thoracic segments smooth, shining. Lateral edges of first abdominal segment rounded behind. On the second to sixth segments, inclusive, the lateral edges are thickened, dark brown in color, and protrude slightly over the stigmata. The former are slightly hollowed out in front and bluntly toothed behind. The segments following are not thickened laterally. A thick brush of brown hairs is present on the dorsal part of the first five abdominal segments, as also a smaller one on the eighth segment; sometimes less prominent ones occur on the sixth and seventh segments. Spiracles somewhat protected by lateral brushes. Mouthparts, antennæ, wings, and legs folded beneath the head. Hind pair of legs extending to the tip of the abdomen. Wings extending beyond the fourth abdominal segment.

IMPORTATION OF CALOSOMA SYCOPHANTA.

This species has been collected in various European countries and shipped to Massachusetts for liberation in the field. It attacks the gipsy moth and many other lepidopterous larvæ and pupæ and has now become firmly established over a large part of the area in Massachusetts and New Hampshire that is known to be infested by the gipsy moth. The species has become so abundant in some of the infested towns that a large number of specimens have been collected and liberated in infested towns where the beetles were not known to occur. Small colonies of this insect have been shipped to New Mexico, California, and to New Brunswick, Canada, in order to test the ability of the species to become established in widely separated regions where the climate and food supply are dissimilar to those prevailing in New England.

BIBLIOGRAPHY.

1736. Réaumur. Mémoires pour servir à l'Histoire des Insectes, v. 2, 514 p., 40 pl. Paris.

Page 45, pl. 37, fig. 14-19. The first published reference of this species, referring to it merely as a scarab, but the illustrations given can not be mistaken for any other but the true *Calosoma sycophanta* L. Notes on the feeding of the larvæ in the nests of processionary caterpillars.

1758. Linnæus, C. Systema Naturæ, ed. 10, t. 1, 826 p. Leipsic.

Page 414. Original description of the species under the genus Carabus.

1761. Linnæus, C. Fauna Svecica, 578 p. Stockholm.

Page 220, No. 790. Somewhat more detailed description with note that "the species is found in trees where they devour lepidopterous larvæ."

1764. Linnæus, C. Museum Ludovicæ Ulricæ Reginæ, Insecta et Conchilia, 720 p.

Page 95. A still more detailed description than the previous two cited above.

1767. Linnæus, C. Systema Naturæ, ed. 10 rev., t. 1, pt. 2, p. 533-1327.

Page 670, No. 12. Description with previous references.

1775. Fabricius, J. C. Systema Entomologiæ, v. 1, 268 p.

Page 239. Description with references and habit notes.

1777. Goeze, J. A. E. Entomologische Beyträge, t. 1, 736 p. Leipsic.

Page 637. This species is listed as *Buprestis sycophanta*.

1785. Fourcroy, A. F. de. Entomologia Parisiensis; sive Catalogus Insectorum quæ in Agro Parisiensi Reperiuntur. 544 p. Paris.

Page 42. Description of the species under the genus Buprestis.

1787. Fabricius, J. C. Mantissa Insectorum, t. 1, 384 p. (p. 197).

1790. Paykull, G. von. Monographia Caraborum Sveciae, 138 p.

Page 63, No. 38. More detailed description than those of preceding references.

1792. Fabricius, J. C. Entomologia Systematica, t. 1, 538 p. (p. 149).

1793. Panzer, G. W. F. Voet's Beschreibungen und Abbildungen hartschaaligter Insecten, Coleoptera, Linn. 5 Theil. (Tab. 37, fig. 32.)

1795. Olivier, A. G. Entomologie ou Histoire Naturelle des Insectes, t. 3, no. 35 (Carabe), p. 42, pl. 3, fig. 31

Long list of references with description and comparative notes to that of *Carabus inquisitor*.

1798. Paykull, G. von. Fauna Svecica, t. 1, 234 p. (p. 127).

1799. Geoffroy, E. L. Histoire Abrégée des Insectes, t. 1, 556 p., 10 pl. Paris.

Page 144. Descriptive notes and references; species listed under the genus *Buprestis*.

1801. Fabricius, J. C. Systema Eleutheratorum, t. 1, 506 p. Kiel.

Page 212. List of references and description. The species is here listed under Weber's new genus *Calosoma*.

1804. Latreille, P. A. Histoire Naturelle Générale et Particulière des Crustacés et des Insectes, t. 3, 411 p. (p. 301).

1810. Gyllenhal, Leonardo. Insecta Suecica, t. 1, pt. 2, 660 p. Scaris.

Page 52, No. 4. Detailed description with references and notes on habitat in southern Switzerland.

1813. Panzer, G. W. F. Fauna Insectorum Germanicæ. Pt. I. Eleutherata, p. 41.

1815. Leach, W. E. The Zoological Miscellany, v. 2, 154 p., 120 pl.

Page 94. The species inhabits Europe, in Britain rare. A few records are given of the species having been collected in England and Ireland.

1826. DeJean, le Comte. Species Général des Coléoptères, t. 2, 501 p.

Page 193. Descriptions and notes on its abundance in the woodlands of central Europe during the caterpillar season.

1830. Gebler, F. A., von. Bemerkungen über die Insekten Sibiriens, vorzuglich des Altai. Ledebours Reise, t. 2, p. 57.

1835. Audouin, V., et Brullé, A. Histoire Naturelle des Insectes, t. 5, p. 92.

Figure and description of larva. Interesting account of the larvæ preying upon caterpillars of *Bombyx dispar* which were feeding upon poplars.

1836. Burmeister, H. Anatomical observations upon the larva of *Calosoma sycophanta*. *In* Trans. Ent. Soc. London, v. 1, p. 235-241.

Detailed descriptions and drawings of the external and internal anatomy of the larva.

1839. Westwood, J. O. An introduction to the Modern Classification of Insects, v. 1, 462 p., 56 fig.

Page 65. Figure and description of larva.

1852. Guyon, G. Capture of *Calosoma sycophanta* in the Isle of Wight. *In* Zoologist, 1852, p. 3359.

1854. Dawson. Geodephaga Britannica. A Monograph of the Carnivorous Ground-beetles Indigenous to the British Isles. xx+224 p., 3 pl.

Page 42. Description with notes on its occurrence in localities of Britain. The author does not consider the species as truly indigenous to that country.

1857. Plant, F. Captures of Coleoptera in Leicestershire. *In* Zoologist, v. 15, p. 5544.

1860. Hayward, W. H. Capture of *Calosoma sycophanta* near Penzance. *In* Zoologist, v. 18, p. 7290.

1860. Morse, A. C. *Calosoma sycophanta* in the Isle of Wight. *In* Zoologist, v. 18, p. 7157.

1863. Reading, J. J. *C. sycophanta* in Devonshire. *In* Zoologist, v. 21, p. 8413.

1872. Deyrolle, E. [Note.] *In* Petites Nouvelles Ent., Annee 4, no. 53, p. 212.

Report of finding adults of *C. sycophanta* on the putrid body of a man who had hung himself in a forest.

1872. Rowe, J. B. *Calosoma sycophanta* at Plymouth. *In* Ent. Mo. Mag., v. 9, p. 117.

1872. Rodd, E. H. Second occurrence of *Calosoma sycophanta* near Penzance. *In* Entomologist, v. 6, p. 224.

1880. Lucas, H. Une note relative a une anomalie presente par un Coléoptère du genre Calosoma. *In* Ann. Soc. Ent. France, v. 10, ser. 5, p. lxxiv.

1895. Lintner, J. A. List of publications of the entomologist. *In* 10th Rpt. N. Y. State Ent. f. 1894, p. 484–506.

Page 491. One specimen of this species found in a box of lemons from Sicily opened in Albany, N. Y.

1897. Heller, K. M. Ueber eine Farbenaberration von *Calosoma sycophanta* L. *In* Ent. Nachr., v. 23, p. 312.

1905–1907. Houlbert, C., et Monnot, E. Coléoptères. Carabides. *In* Trav. Sci. Univ. Rennes, Fauna Ent. Américaine, t. 1, pt. 2, p. 298–379, fig. 68–145.

Page 292, fig. 71. Figure and description with distribution notes and biologic data on the larvæ.

1906. Maindron, Maurice. Remarques sur divers Carabidæ pris en Corse. *In* Bul. Soc. Ent. France f. 1906, p. 280–282.

Record of a specimen taken at 1,200 meters of altitude.

1910. Fiske, W. F. Parasites of the Gipsy and Brown-tail Moths introduced into Massachusetts. 56 p., 22 fig. Boston.

1911. Howard, L. O., and Fiske, W. F. The Importation into the United States of the Parasites of the Gipsy Moth and the Brown-tail Moth. U. S. Dept. Agr. Bur. Ent. Bul. 91, 344 p. (p. 59, 62, 253–255), 28 pl., 74 fig.

1911. Burgess, A. F. *Calosoma sycophanta*. U. S. Dept. Agr. Bur. Ent. Bul. 101, 94 p., 9 pl., 22 fig.

1912. Burgess, A. F., and Collins, C. W. The value of predaceous beetles in destroying insect pests. *In* U. S. Dept. Agr. Yearbook f. 1911, p. 453–466 (p. 463, 464), pl. 52–62, fig. 15–20.

1915. Burgess, A. F., and Collins, C,. W. The Calosoma Beetle (*Calosoma sycophanta*) in New England. U. S. Dept. Agr. Bul. 251, 40 p., 8 pl., 3 fig.

CALOSOMA RETICULATUM (Fab.).

ORIGINAL DESCRIPTION.

[Translation.]

Winged, black, elytra reticulated, greenish-coppery, margin of thorax greenish. Habitat in Europe, Mus. Dom. Zechuck.

Stature and magnitude of *C. inquisitor*. Head, with antennæ, black, ferrugineous on the last joint. Thorax blackish, with golden reflexed margin. Elytra very finely reticulate, green, shining. Feet black.

EARLY RECORDS OF THE SPECIES.

The species was first described in 1787 by Fabricius as *Carabus reticulatus* and its habitat given as Europe. A more detailed description was given by Paykull in 1790 under the same genus with a note as to the scarcity of the species in southern Switzerland. Fabricius, in 1801, gave a further description of the species, placing it in the genus Calosoma and noting its occurrence in Germany. Latreille, in 1804, wrote that the species occurred in Germany, but very rarely. Gyllenhal published an account of the species in 1810 and included a note to the effect that it occurred rarely in southern Switzerland in shaded places. Dejean, in 1826, recorded it as occurring in Sweden, North Germany, and Austria, but very rarely everywhere.

All the information secured on this species from the literature and from the small numbers forwarded to the laboratory by Miss Marie Ruhl, Zurich, Switzerland, indicates that it is not common.

IMPORTATIONS.

The first importation of this species was received September 5, 1907, from Miss Ruhl, and contained one male and five females living and one female that had died en route. In 1908 50 males and 61 females alive, and 23 males and 15 females dead were received, and in 1910 a few specimens arrived.

The total receipts for 1907–1910, inclusive, were 172 specimens—52 males and 72 females alive and 28 males and 20 females dead. These notes would indicate that the species is not common in many localities of Europe, as Miss Ruhl received specimens from collectors at various points in France, Germany, Switzerland, and possibly other countries.

HABITS OF ADULTS.

Observations made on the climbing habits of these adults in 1911 revealed the fact that the beetles can climb trees when it is necessary to obtain food, but they ordinarily secure it on or near the ground like *Calosoma calidum*. They climb slowly and awkwardly, but when on the ground can travel swiftly. It has been proved that both adults and larvæ can and do ascend trees voluntarily, and it is believed from the meager results secured at the laboratory that they do this in all stages when the available food supply on the ground becomes exhausted.

HIBERNATION.

Four females were put into hibernation cages in the fall of 1907, and three of these emerged from May 16 to 30, 1908. Sixteen adults that were fed in jars during the summer of 1908 entered hibernation from July 30 to August 29 of that year, or an average date of August 17. Seven of the same beetles emerged the following spring between May 11 and May 27, or an average date of May 18. The depth of cavities of a few that entered hibernation in 1910 was about 1 inch.

One female that was reared in 1910, and issued as an adult July 15, came to the surface and fed until August 3 before entering hibernation. This female emerged May 15, 1911.

Accurate information as to the depth of cavities was difficult to secure without disturbing the beetles, but it is probable that they go deeper than 1 inch in most cases.

FOOD CONSUMED BY ADULTS.

Three pairs of beetles were fed in jars in 1908, but no reproduction resulted. Each female averaged 11½ small caterpillars per day from the date of emergence from hibernation to June 23, when males were received from Europe and placed in the jars. Fourth to sixth stage caterpillars of *Euproctis chrysorrhœa* and *Porthetria dispar* were supplied. After the males were added, June 23, the average per day for each beetle was two sixth-stage gipsy-moth caterpillars.

Feeding records were kept in 1909 of four pairs of beetles which were received from Europe in 1908, and the results secured are indicative that the species is a ravenous caterpillar hunter, as in one case a pair destroyed as many or more large caterpillars in a season than is normally killed by *Calosoma scrutator* or *C. sycophanta.*

TABLE 17.—*Feeding record of four pairs of Calosoma reticulatum, 1909.*

Pair No.	Feeding record started.	Ceased feeding.	*Malacosoma americana* third to sixth stages.	*Porthetria dispar,* sixth stage.	Total.
1504...	[1] May 27	[2] July 2	159	10	169
1506...	May 14	Aug. 13	504	24	528
1508...	[1] June 3	[2] July 7	196	18	214
1593...	May 15	[2] July 21	297	65	362

[1] Females fed on steak 8 to 10 days before records were started.

[2] Females died a few days later.

It will be noted from Table 17 that these beetles are voracious feeders. The average number of caterpillars consumed by each of the four pairs was 343 for the season of 1909. All of the females except No. 1508 reproduced. The average number of caterpillars consumed per day during the feeding season for pair No. 1508 was seven, and the average for the four pairs during the time each fed was six.

Pair No. 1506 lived to emerge from hibernation in the spring of 1910 and fed until July 2 before the female died. Two hundred and fourteen fifth and sixth stage caterpillars of *Noctua clandestina, Malacosoma americana,* and *Porthetria dispar* were consumed by the pair between April 27 and July 2, 1910. The pair reproduced in 1909 and 1910, which accounts for the large amount of food consumed each year.

Two pairs of beetles reared in the laboratory vivarium issued as adults in July, 1909, and came to the surface of the earth in the jars. Five sixth-stage caterpillars of *Porthetria dispar* were consumed by one pair and 13 by the other. All these beetles died during the latter part of July and the first half of August of the same year. This same habit of coming to the surface and feeding almost immediately after issuance as adults has been noted in the case of *Calosoma calidum,* but the beetles often died before the following spring.

REPRODUCTION.

Many specimens that were received from Europe in 1908 were kept in jars and cages for reproduction during the summer, but these did not reproduce until 1909 and 1910. Four females received in June, 1908, reproduced as follows in 1909: The first female deposited 39 fertile eggs between June 7 and 28 and died July 6; the second, 71 fertile eggs between June 14 and June 27, then ceased feeding and entered hibernation August 18; the third, 20 fertile eggs between

June 20 and 25, and died July 10; the fourth, 92 fertile eggs between June 15 and 30, and died July 28. The total number of larvæ that hatched from eggs of these four females was 222, or an average of 56 for each.

The second female, which deposited 71 fertile eggs in 1909, entered hibernation late in the summer, emerged the following spring, deposited 82 fertile eggs between May 26 and June 30, and died July 2, 1910. This female deposited a total of 153 fertile eggs in two seasons. Copulation was observed with the pair on May 20 and 28 and June 2 of the latter year. The females in some cases lived longer than the males. A few fertile eggs were also deposited in 1911 by two females—beetles received from Europe in July, 1910. One female reared in the vivarium at the laboratory in 1910, when placed with an old male in 1911, was observed to copulate, and on June 3 of that year it deposited one infertile egg before dying.

All the notes secured on the reproduction of beetles of this species tend to prove that they ordinarily do not reproduce the summer after issuing as adults. None of those received from Europe and confined in jars reproduced until the year following their receipt or later, and they were in their first year or older when received. The young female reared at the laboratory that deposited one infertile egg is an exception as far as the record goes, but this female died almost immediately thereafter. Most of the beetles passed the first year under abnormal conditions, as they were deprived of food during the long voyage to America, and this may in part explain their behavior.

LONGEVITY.

June 23, 1908, a large shipment of beetles was received from Europe, and eight pairs were confined in jars, while others were liberated in a colony. One pair of beetles, No. 1506, hibernated successfully for two winters and died, the female July 2, 1910, and the male September 2 of the same year. This pair of beetles were larvæ and pupæ in the summer of 1907 or earlier and lived three years or more. The female produced 71 fertile eggs in 1909 and 82 in 1910. No eggs were deposited in 1908. Many of the other beetles in this series died after one or two summers at the laboratory and may have been older when collected. Three years is probably the age limit in the adult stage for this species.

COLONIES.

June 28, 1908, the junior writer liberated 38 males and 45 females of this species in a wood lot in Winchester, Mass. An ample supply of caterpillars of *Porthetria dispar* was available, and the woods adjoined a market garden, where a greater or less number of cutworms were present. The species has not since been recovered, although occasional visits have been made to secure evidence of its presence.

In June, 1911, a larval colony of 27 specimens in the first and second stages was liberated in a garden in North Saugus, Mass., where cutworms were very abundant. This colony was very small and no evidence has been secured that the species has become established.

The attempts at colonizing this species in eastern Massachusetts have thus far been unsuccessful. There is a possibility, however, that recoveries may be made within a few years. It is believed that this species would be a valuable adjunct to the North American fauna, and the fact that the larvæ climb to some extent adds to their efficiency as caterpillar destroyers. It is expected that this would be a more valuable species for establishment in New England than *Calosoma auropunctatum*, although less is known about the larval habits of the latter.

THE EGG.

The eggs are yellowish white and elliptical in form, tapering toward one end. Twelve fresh eggs gave the following average measurements: Length, 5.5 mm.; width, 2.5 mm. The size varies, but they run somewhat larger than those of *Calosoma sycophanta*, although the adults average considerably smaller.

Hatching data were secured on 89 eggs deposited between June 3 and 22, 1909, and the time in the egg stage ranged from 4 to 14 days, or an average of 10. Similar data were again secured in 1910 for 82 eggs deposited between May 26 and June 30, and the number of days passed ranged from 5 to 20, or an average of 13. In 1911, 54 eggs were deposited between May 22 and June 20, the period in the egg stage ranging from 5 to 12 days, or an average of 8. Most of the eggs included in the record of 1910 were deposited during the latter part of May, when the temperature was much lower than for those deposited in June, 1909. The records secured in 1911 are rather similar to those of other species studied.

BRIEF DESCRIPTION OF LARVA.

First stage (Pl. XIV, *A*, *B*).—Of medium size, fusiform. Average length of 12 specimens, 11 mm.; width, 3 mm. Caudal appendages long, straight, tapering gradually from base to apex, bearing numerous long spines. Color glossy black.

Second stage (Pl. XIV, *C*, *D*).—Average length of 10 specimens, 18 mm.; width, 3.6 mm. Caudal appendages rather erect, tip curved backward. Color, shining black above. No reddish-brown patch on dorsum of last segment.

Third stage (Pl. XV, *A*, *B*).—Robust in form. Average length of 8 specimens, 25.7 mm.; width, 5.3 mm. Caudal appendages short, erect, but slightly curved downward beyond dorsal protuberance, which is rather short and arises slightly more than one-half the distance from base to tip. Color shining black dorsally. Ventral plates dark brown. No reddish-brown patch at base of caudal appendages.

TIME REQUIRED TO COMPLETE LARVAL STAGES.

Observations were made on a series of the larvæ fed in 1909 and 1910 to ascertain the time required for the completion of the different larval stages. From those observed in 1909, which hatched June 21 to 28, an average of 3 days was required for the first stage, 4 for the second, and 14 for the third to the time when feeding ceased. Another small series reared in 1910, which hatched June 13 and 14, required an average of 6 days for the first stage, 4½ for the second, and 9 for the third.

Some of the larvæ of the series of 1909 molted in 2 days after hatching, which is unusual, as 4 days is common with most species of Calosoma.

From 3 to 7 days were passed by the larvæ in making a cavity and preparing for pupation. A fair average covered by this period is 4 or 5 days, making the total number passed in the larval stages 25 to 26 days.

FOOD CONSUMED BY LARVÆ.

Daily records were kept of a series of larvæ reared in 1909 and 1910. It was observed that the larvæ destroy and consume large numbers of caterpillars in comparison to larvæ of *Calosoma calidum.* Large caterpillars of *Malacosoma americana* and *Porthetria dispar* were offered for food. A few records follow:

TABLE 18.—*Food eaten by larvæ of Calosoma reticulatum, 1909, 1910.*

No.	Date hatched.	Date ceased feeding.	*Malacosoma americana* caterpillars, fourth to sixth stages.	*Porthetria dispar* caterpillars, sixth stage.	Total.
	1909	1909	1909	1909	1909
1506A	June 21	July 8[1]	6	20	26
1506B	...do.....	14	8	31	39
1506C	...do.....	12	5	33	38
1506D	...do.....	16[1]	6	23	29
1506F	...do.....	12[1]	7	29	36
1506I	...do.....	12	7	37	44
	1910	1910	1910	1910	1910
1506AB	June 13	July 5[1]	[2] 6	22	28
1506AC	...do.....	2	[2] 5	29	34
1506AD	...do.....	June 30	[2] 4	15	19
1506AE	...do.....	July 4	[2] 4	45	49
1506AF	June 14	5[1]	[2] 5	35	40
1506AG	...do.....	6[1]	[2] 4	45	49

[1] Full-grown larva died.

[2] All sixth-stage caterpillars.

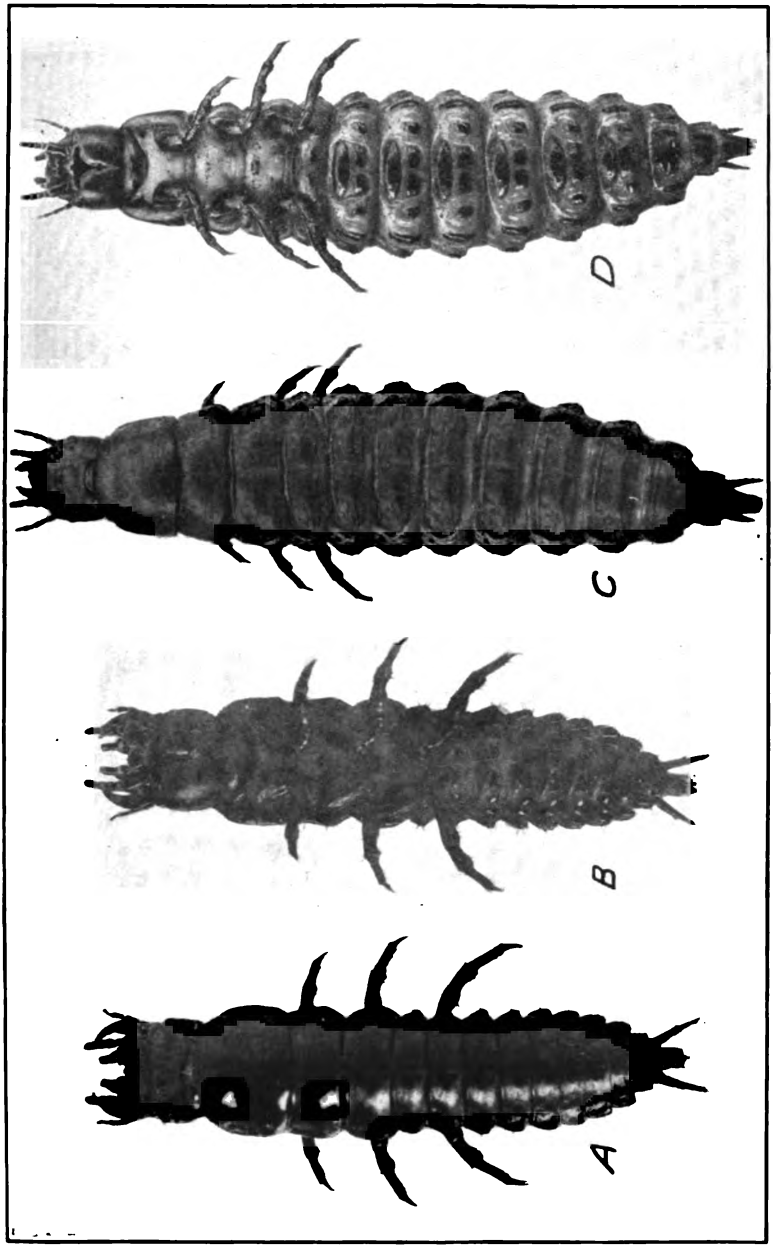
Very little variation was found between the two series, as an average of 36 caterpillars was destroyed by 6 specimens fed in 1909 and 37 by the same number in 1910. The larvæ in both series continued their activity and feeding over an average period of 21 days. The same period is required by larvæ of *Calosoma calidum.*

Three larvæ were fed to maturity in 1911 on pupæ of *Malacosoma americana* after the latter had been stripped from their cocoons, and when necessary large caterpillars were substituted. Ten pupæ were killed and wholly or partly devoured by the first-stage larvæ, nine pupæ and three fifth-stage caterpillars by the second-stage larvæ, and nine pupæ and three sixth-stage caterpillars by the third-stage larvæ. Assuming that about the same amount of food was contained in a large caterpillar as in a pupa, an average of 11 to 12 pupæ were consumed to complete the larval growth.

HABITS OF LARVÆ.

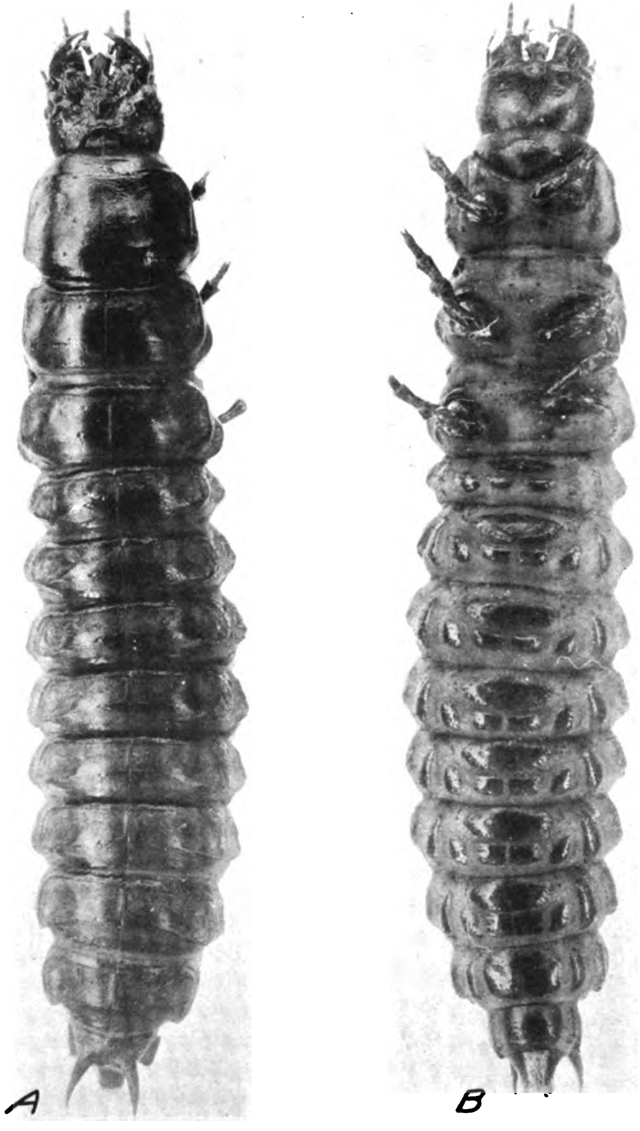
During the spring and summer of 1911 data were collected in an experimental way to determine the climbing habits of these larvæ.

May 29 six young first-stage larvæ were tested (Pl. III), and one of them immediately climbed upon the tree to a height of 5 feet, then fell to the ground. This larva climbed with considerable ease. Another specimen ascended 1½ feet before falling. June 5 all the larvæ had molted and made no attempt to climb of their own volition while they were under observation. They were put upon the bark



CALOSOMA RETICULATUM.

A.—First-stage larva, dorsal view, ×6. *B.*—Same, ventral view, ×6. *C.*—Second-stage larva, dorsal view, ×4. *D.*—Same, ventral view, ×4. (Original.)



CALOSOMA RETICULATUM.

A.—Third-stage larva, dorsal view, ×4. *B*.—Same, ventral view, ×4. (Original.)

at various times, but did not climb more than 4 or 5 inches. These larvæ were then removed and others substituted. June 24 two first and two second stage larvæ were tested, and one climbed 2 feet before falling. June 25 at 8 a. m. one of the second-stage larvæ was found on the bark of the tree 18 inches from the ground, but there were no signs that it or the others had entered the food cage at the top during the night.

June 26 a sixth-stage caterpillar of *Porthetria dispar* was found devoured in the food cage at the top, evidently by a third-stage larva, as there was a large hole in one side of the caterpillar where it had entered. A second-stage larva when placed upon the tree crawled up 18 inches before falling.

June 27, in the forenoon, a third-stage larva was found on the bark 15 inches from the ground, but it had not entered the food cage during the night.

June 28, in the forenoon, the same larva was again found on the bark of the tree 6 inches from the ground.

June 29, in the forenoon, a third-stage larva was found in the food cage at the top of the tree, and had devoured a sixth-stage caterpillar.

July 3 a second-stage larva was found in the earth at the base of the tree, but had entered the food cage at the top during the night and devoured two sixth-stage caterpillars of *Porthetria dispar*.

July 4 it was again noted that the larva had entered the food cage and devoured another large caterpillar.

July 5 the same operation was again noted except that this time a part of two caterpillars had been consumed. July 11 the larva died after growing weaker for two or three days. It had probably been injured in falling.

These experiments reveal the fact that larvæ of this species can and do climb in all stages. The first-stage larvæ did not quite reach the food cage at the top while the second and third stage larvæ seemed to have easy ingress and egress. These results compare quite favorably with the climbing habits of larvæ of *Calosoma sycophanta*.

CANNIBALISM AMONG LARVÆ.

An experiment was conducted in the summer of 1909 to find out how many days after hatching these larvæ could be fed together in jars before planting them in colonies in the field. They were confined in large battery jars about 8 inches deep and 6 inches in diameter with about 2 inches of earth in the bottom. Caterpillars of *Porthetria dispar* were supplied daily with fresh leaves so as to keep them feeding on the earth and to enable the larvæ of *Calosoma reticulatum* to reach them easily. The larvæ hatched between June 21 and June 29, 1909, and were all removed from the jars, July 1. The results are given in Table 19.

TABLE 19.—*Extent to which larvæ of Calosoma reticulatum prey on one another.*

Number of days after hatching.	Per cent alive when removed.	Number of days after hatching.	Per cent alive when removed.
Days.		*Days.*	
11	21	6	43
10	25	5	40
8	20	3	94
7	6		

The results obtained show that the larvæ prey upon one another to a great extent after the third day, or about the time they enter the second stage. The same is true with the other species of Calosoma thus far studied. However, the writers have fed larvæ of *C. sycophanta* on pupæ of *Porthetria dispar* in this manner to the end of the second stage without suffering heavy losses from cannibalism. Pupæ are more desirable than caterpillars for food, as they do not move on the surface of the earth, whereas caterpillars are continually crawling about the sides of the jar, where they are out of reach of the beetle larvæ.

THE PUPA.

[Pl. XVI, *A*, *B*, *C*.]

The average length of three females was 19.2 mm. and the width 7.9 mm. The average length of two males was 16.3 mm. and the width 7.9 mm.

Adults were reared in the laboratory vivarium in 1909 and 1911, and data on the time required to complete the pupal stage were secured each year. Many times the larvæ were not considerate enough to make their cavities at the side or bottom of the glass jars in which they were confined, so that it was difficult to secure exact notes on the time of entering and completing this stage.

One larva, No. 1506–I, ceased feeding July 12, 1909, and buried itself in the earth for pupation. A female issued July 23. About 5 days were passed in the prepupal stage and 13 days as a true pupa. One larva, No. 1506–AC, ceased feeding July 2 and pupated about July 5, but the adult died when emerging, July 17. In this case 3 or 4 days were passed in the prepupal stage and 11 or 12 days as a pupa. Other data obtained during those years and in 1911 gave similar results.

BIBLIOGRAPHY.

1787. **Fabricius**, J. C. Mantissa Insectorum, t. 1, 348 p.
Page 197. Original description of the species under the name of *Carabus reticulatus.*

1790. **Paykull**, G. von. Monographia Caraborum Sveciae, 138 p.
Pages 67–68. Lengthy description of the species under the name of *Carabus reticulatus.*

1801. **Fabricius**, J. C. Systema Eleutheratorum, t. 1, 506 p.
Page 213, no. 9. A more detailed description than is given by the same author in 1787, this species being put under the genus Calosoma.

1804. **Latreille**, P. A. Histoire Naturelle Générale et Particulière des Crustacés et des Insectes, t. 8, 411 p.
Pages 300–301. Brief comparison of this species with *C. inquisitor.*

1810. **Gyllenhal**, L. Insecta Svecica, t. 1, pt. 2, 660 p. (p. 51, no. 3.)

1813. **Panzer**, G. W. F. Fauna Insectorum Germanicae. Pt. I. Eleutherata, p. 41.

1826. **DeJean**, le Comte. Species Général des Coléoptères, t. 2, 501.
Page 208. Description comparative with that of *C. inquisitor* and notes on its occurrence in Europe.

CALOSOMA ANGULATUM Chev.

ORIGINAL DESCRIPTION.

[Translation.]

So. Calif. Length 27 mm.

Blackish-blue. Head punctate. Thorax black, angled in the middle, marginate and dark blue on the sides, smooth, punctate at base and apex, with longitudinal line scarcely impressed. Elytra with 14 ribs, interstices latticed, deeply towards the humerus, striate-punctate, with three rows of oblong punctures more marked in the single beetle examined; apex acutely rounded.

EARLY RECORDS AND DISTRIBUTION OF THE SPECIES.

This species was described by A. Chevrolat in 1834, the type specimen being taken in southern California. The description refers to 14 ribs or elevations on the elytra. A careful examination was made of the specimens in the LeConte collection in the Museum of Comparative Zoology, Cambridge, Mass., and 16 elevations were noted in each case. There has been some confusion between *Calosoma angulatum* Chev. and *Calosoma angulatum* Lec., but the latter name was changed to *prominens* by LeConte. *Calosoma angulatum* Chev. has been taken in Arizona, California, and Texas. There is also a record from Mexico where it probably occurs in many localities.

BIBLIOGRAPHY.

1834. Chevrolat, A. Coléoptères du Mexique. vii p., 211 l. 1834. Strasbourg.

1881-1884. Bates, H. W. Biologia Centrali-Americana, Insecta. Coleoptera, v. 1, pt. 1, 316 pp., 13 pl.

Pages 21 and 262, pl. 2, fig. 12. Habitat notes in several localities of Mexico. "A closely allied but sufficiently distinct species (*C. angulicolle* Chaud.) occurs near Santa Marta, Columbia."

CALOSOMA PEREGRINATOR Guer.

(Syn.: *C. carbonatum* Lec.)

ORIGINAL DESCRIPTION.

[Translation.]

Body wholly black, almost entirely dull on the dorsal surface, a little shining on the ventral side. Head small, very heavily granulated with an oblique dimple in front, near the insertion of the antennæ. Thorax transverse, truncate, nearly straight to its two extremities, angular at each side in the middle, with the space between the lateral angle and the anterior margin rounded, with the space between the lateral angle and the inferior margin rounded; and the space between this same angle and the lower margin cut off straight. Its disc finely granulate, with the edges more heavily wrinkled and a feeble longitudinal line sunken in the middle. Shield small, triangular. Elytra very much broader than the thorax at their base, elongate, rounded anteriorly and posteriorly, nearly parallel in the middle, heavily margined, presenting some 14 or 15 lines of small sunken dots, gradually disappearing towards the posterior extremity of the elytra, and three series of distant dots, scarcely visible, without the aid of the lens. Underside of the body and the feet nearly smooth; some large sunken dots on the lateral sides of the metathorax and the first abdominal segment, the following very finely striate longitudinally to the middle.—L. 0,026; l. 0,011.

This species is distinguished from all those which have been described by M. Dejean by reason of its thorax of angular margins. It approaches the character of *C. angulatum* of M. Chevrolat (Col. du Mex., fasc., 2 mars 1843). But with this latter the elytra have each fourteen elevations.

EARLY RECORDS OF THE SPECIES.

This species was described by M. Guérin Méneville, in 1844, from specimens collected in Mexico. He erroneously reduced *C. prominens* Lec. to a synonym of this species. In 1863 LeConte described a new species as *C. carbonatum*, but this was recognized as a synonym of *C. peregrinator* Guér. by G. H. Horn, in 1883, and was so published by Mr. H. W. Bates during the following year.

The writers have studied the descriptions and compared labeled specimens and have reached the same conclusion.

DISTRIBUTION.

Museum specimens indicate that this species has been collected at an altitude of 4,400 to 6,000 feet in New Mexico and Texas. It has also been taken in Arizona, California, Kansas, and New Mexico. Numerous cases are also on record of the species having been collected in Mexico.

COLLECTIONS AND SHIPMENTS.

Dr. A. W. Morrill, of Phoenix, Ariz., in the latter part of August, 1912, wrote that both adults and larvæ of this species were fairly common near Prescott, Ariz., and were feeding upon the variegated cutworm. He forwarded to the laboratory at the same time one pair of live adults and four third-stage larvæ, two of which were dead on arrival. Under date of October 8, five pairs of adults, one female of which was dead, were received from Mr. L. L. Bates, Prescott, Ariz., an assistant of Dr. Morrill. The beetles were placed in jars of earth for study.

HABITS OF ADULTS.

One pair of the beetles received October 8 were put at the base of the tree to test their ability to climb. (Plate III.) Both beetles climbed to the top of the tree without urging and remained there until removal. They were left at the base of the tree in the afternoon and on the following morning were again found at the top. The beetles climb rather slowly in comparison to adults of *C. frigidum* Kirby, or *sycophanta* L., and probably secure most of their food near the ground.

FEEDING RECORDS OF ADULTS.

Beginning October 8, 1912, daily feeding records were kept of two pairs in the hope that they might reproduce. The jars were kept inside the laboratory and the beetles remained active until December 2, when the food supply became exhausted. On this latter date the jars were transferred to the cellar and the beetles entered hibernation in a few days.

TABLE 20.—*Feeding record of two pairs of Calosoma peregrinator, 1912.*

Pair No.	Record started.	Transferred to cellar for hibernation.	Full-grown larvæ and pupæ of *Pontia rapæ* and *Plusia brassicæ* consumed.
5867.	Oct. 8...	Dec. 2...	334
5868.	...do....	...do....	268

From 10 to 16 full-grown larvæ were consumed some days by a single pair. The average larvæ consumed per day for the first pair, No. 5867, during the feeding period was 6. The beetles in question did not reproduce during the fall of 1912. The same pair issued from hibernation June 8 and had consumed 122 fifth and sixth stage larvæ of *Malacosoma americana* and *Porthetria dispar* by July 21. On this date the male died, and as the female ate very little the record was discontinued temporarily. On September 10 the female began feeding ravenously and consumed 48 large larvæ of *Hyphantria cunea* during the next 19 days.

The records secured are too incomplete to form an accurate idea of the value of this insect as a destroyer of lepidopterous larvæ. They indicate, however, that under favorable natural conditions it is an important species.

HIBERNATION.

Of the small lot of adults received during the fall of 1912 a few after feeding for a period entered the earth for hibernation. The jars were then filled with earth and transferred to the laboratory cellar, where the temperature ranged from 40 to 65° F. during the winter, as it was thought that this species could not withstand the severe weather outside. Two pairs were living when the jars were taken outside in the spring and could be seen in their cavities. One pair of these beetles came to the surface for food September 10 and 23, respectively. The other pair was still in cavities in the jar. The male of the latter jar emerged for food August 31, 1914, the female dying in its cavity that summer.

REPRODUCTION.

Only one pair of the beetles issued from hibernation in the spring so as to reproduce at the normal time of other species of the genus. The female of this pair issued June 8, 1913—the male remaining on the surface all winter, as the jar where they hibernated was kept in the cellar. Copulation was observed June 11 and 30. Eggs were removed from the jar June 28 and 29 and July 3 and 4. Eight larvæ hatched. The male died July 21 and the female during hibernation the following winter.

DESCRIPTION OF LARVA.

First stage.—Robust in form, tapering gradually to anal end. Average length of five alcoholic specimens, 8.2 mm.; width, 2.1 mm. Caudal appendages rather long (1.8 mm.), slender, tapering gradually from base to apex, bearing numerous long spines. Dorsal protuberance indistinct in this stage. Color brownish-black on the dorsum, ventral plates grayish-brown. Anterior ventral plates broad in middle and tapering to a point at each end.

No second-stage larvæ were available for description.

Third stage.—Very robust in form, broad. Length of one alcoholic specimen that had fed to some extent in this stage, 23.5 mm.; width, 6.5 mm. Caudal appendages almost straight, slender, only slightly angled downward beyond dorsal protuberance. Protuberance short, erect, located more than one-half distance from base to tip. Color dull to shining black, ventral plates dark brown. Pronotum nearly square, but rounded on anterior angles. Tergites projecting slightly laterad in partly fed larvæ, with posterior angles obtuse, except the seventh and eighth abdominal, and pointing slightly backward. Posterior angles of seventh, eighth, and ninth tergites rather acute; angle of ninth very small, not prominent. No reddish-brown patch on dorsum of anal segment.

NOTES ON LARVÆ AND PUPÆ.

One female pupa measured 20.5 mm. long and 9 mm. wide.

Two live third-stage larvæ were received September 4, 1912. One died September 5 without feeding and the other consumed the greater part of a full-grown larva of *Estigmene acræa* and one of *Papilio turnus*, and entered the earth September 8. A cavity was formed and pupation took place September 12 or 13. The pupa was removed to the top of the earth for study and although the specimen was not allowed to develop to the adult stage, it was evident that about 14 days are spent as a pupa.

A few larvæ hatched from eggs in 1913, but all died in the first and second stages. Large caterpillars and pupæ of *Porthetria dispar* were offered, and the beetle larvæ fed upon them readily.

BIBLIOGRAPHY.

1844. **Guérin-Méneville**, M. Description de Coléoptères nouveaux découverts par M. A. Niéto dans L'interieur du Mexique. *In* Revue Zoologique, ser. 1, v. 7, p. 253–262.

Page 255. Original description of the species and comparisons made of the angled thorax to that of *C. angulatum* Chev.

1863. **LeConte**, J. L. Notes on the species of Calosoma inhabiting the United States. *In* Proc. Acad. Nat. Sci. Phila. f. 1862, v. 14, p. 52–53.

Description of *Calosoma carbonatum* from New Mexico, upper Texas, and Lower California.

1877. **Popenoe**, E. A. A list of Kansas Coleoptera. *In* Trans. Kansas Acad. Sci. f. 1876, v. 5, p. 21–40.

Page 22. "Western Kansas."

1882–83. **Horn**, G. H. Miscellaneous notes and short studies of North American Coleoptera. *In* Trans. Amer. Ent. Soc., v. 10, p. 269–312, pl. 9.

Page 270. The writer places *C. carbonatum* Lec. as a synonym of *C. peregrinator* Guér. and also corrects the misunderstanding that *C. prominens* Lec. is a synonym of the latter species.

1881–1884. **Bates**, H. W. Biologia Centrali-Americana, v. 1, pt. 1, 316 p., 13 pl.

Pages 21, 262. The writer quotes Flohr as classing *C. carbonatum* Lec. as synonymous with *C. peregrinator* Guér. He also states that *C. peregrinator* Guér. and *C. prominens* Lec. are distinct species, although LeConte had promised to unite the latter to the former.

1893–94. **Horn**, G. H. The Coleoptera of Baja California. *In* Proc. Cal. Acad. Sci., 2d ser., v. 4, p. 302–449, pl. 7–8.

Page 307. *C. carbonatum* Lec. is given as a synonym of *C. peregrinator* Guér. with habitat as localities in southwestern United States and Mexico.

1897. **Coquillett**, D. W. Revision of the Tachinidae of America north of Mexico. U. S. Dept. Agr. Div. Ent. Tech. Ser. No. 7, 154 p.

Page 10. Coquillett records the breeding of *Biomyia georgiæ* from *Calosoma peregrinator* at Los Angeles, Cal., June 25, 1888.

CALOSOMA PROMINENS Lec.

ORIGINAL DESCRIPTION.

Black; head very variably punctate, deeply impressed on both sides, thorax much wider than long, sides angled acutely, with margin scarcely reflexed, narrowed at base, somewhat rounded, finely wrinkled, punctate at posterior, elytra shining, finely punctate in rows, punctures larger towards the base, interstices scarcely corrugated. Length 1.3. Dead specimen about Pimas, Calif.

This species was described by Le Conte in 1851 as *Calosoma angulatum*, but this name was preoccupied, having been used in 1834 by A. Chevrolat for a very different species of Calosoma from southern California. LeConte discovered this fact, and in 1853 proposed the name *prominens* for this species with the angled thorax. It has been recorded from several localities in Arizona, California, and New Mexico, and occurs in Mexico.

BIBLIOGRAPHY.

1852. **LeConte**, J. L. Description of new species of Coleoptera from California. *In* Ann. Lyc. Nat. Hist. N. Y. f. 1851, v. 5, p. 125–216.

Original description of the species under the name of *Calosoma angulatum*. Habitat about Pimas, Cal.

1853. **LeConte**, J. L. Notes on the classification of the Carabidæ of the United States. *In* Trans. Amer. Phil. Soc., v. 10, n. s., pt. 3, art. 27, p. 364–403.

The writer announces the preoccupancy of *Calosoma angulatum* by Chevrolat and proposes to call his new species, also with angled thorax, *Calosoma prominens*.

1881–1884. **Bates**, H. W. Biologia Centrali-Americana, Insecta, Coleoptera, v. 1, pt. 1, 316 p., 13 pl.

Pages 21, 262. The author had the opportunity of examining Guérin's type of *C. peregrinator* along with a large series and states with certainty that it is quite distinct from *C. prominens*. LeConte, himself, at one time proposed to unite them.

1893–1894. **Horn**, G. H. The Coleoptera of Baja California. *In* Proc. Cal. Acad. Sci., 2d ser., v. 4, p. 302–449, pl. 7–8.

Page 307. Notes on habitat as follows: "Western Arizona, southern Mojave region, northern Sonora, El Taste."

CALOSOMA PARVICEPS Casey.

ORIGINAL DESCRIPTION.

Rather stout, with relatively very small head and prothorax, deep black, and devoid of metallic reflection throughout, the integuments rather shining. Head three-fifths as wide as the prothorax, evenly and feebly convex, not rugose but finely, evenly and rather closely punctured, becoming smooth at apex where the lateral impressions are narrow and very deep; labrum dilated and rounded at the sides, transverse at apex, with a broad and very shallow median sinuation, the surface transversely impressed; antennæ short and rather stout, only slightly longer than the head and prothorax, the third joint fully three times as long as the second. Prothorax moderately transverse, about four-fifths wider than long, widest at the middle where the sides are obtusely and somewhat bluntly angulate, thence very moderately convergent and broadly, evenly arcuate to the apex, oblique and straight behind, becoming slightly sinuate near the base, the latter rather narrower than the apex and somewhat as in the preceding species; disk broadly and very feebly convex, polished, feebly wrinkled, finely and rather sparsely punctate, the punctures becoming coarser and subcoalescent at the sides, more numerous in the impressions near the basal angles; side margins defined by a rather thin, strongly reflexed bead; median line fine and very feeble. Elytra oblong, scarcely more than one-third longer than wide, fully twice as wide as the prothorax, only slightly wider at apical third than at base, the sides very feebly arcuate and very narrowly reflexed; disk moderately convex, with scarcely impressed even series of extremely fine punctures, which become stronger toward base, the intervals there becoming transversely broken by arcuate impressed lines as in *peregrinator*, the three series of interstitial asperate punctules very feeble; marginal punctures visible only toward base, the submarginal asperate punctures rather widely separated and uneven. Legs moderate in length and quite slender. Length 16.5 mm.; width 7.5 mm.

The anterior tarsi of the male have the first three joints rather feebly dilated and densely pubescent beneath, the pad of the first joint small and apical; the hind trochanters and intermediate legs are not modified. *Parviceps* also belongs near *peregrinator*, and greatly resembles the preceding species at first glance; it however, differs in sculpture, structure of the labrum, in its much deeper epistomal impressions, less transverse prothorax with less rounded side angles, shorter and broader elytra and in several other minor characters.

This species was described by Col. Thos. L. Casey in 1897.[1] The type specimen or specimens were taken in Arizona. The description compares this species to *peregrinator* Guér., but it is much smaller than the latter. The species has also been recorded from San Diego and San Clemente Island, Cal.

CALOSOMA LUGUBRE Lec.

ORIGINAL DESCRIPTION.

Black, shining, face sparingly punctate, short thorax, with sides much rounded and somewhat angled, truncate at the base, broadly depressed on both sides; with elytra broader than the thorax by one-half, punctate in series, with punctures larger towards the base and grooves transverse and joining. Length 1.08 inches.

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[1] Casey, T. L. Coleopterological notices. *In* Ann. N. Y. Acad. Sci., v. 9, p. 285–683 (p. 341–342), 1896–1897.

EARLY RECORDS OF THE SPECIES.

The writers have been able to find very little published on this important and interesting species. Le Conte described it in 1853, but no note was incorporated in the description as to the location from which it was taken. Prof. L. Bruner, in 1890, noted it with *C. externum* partly devouring May beetles which were flying to lights in large numbers. Dr. W. D. Hunter of the Bureau of Entomology and his assistants have observed large numbers of these beetles in Texas flying to lights at night during September and October.

DISTRIBUTION.

Collection data at hand show that this species occurs rather commonly at various times in Texas and Kansas, for it has been reported from many localities in these States. It has also been taken in Oklahoma, Nebraska, and New Mexico, and it probably exists in other States.

COLLECTIONS AND SHIPMENTS.

September 23, 1909, Mr. W. F. Fiske, recently of the Bureau of Entomology, was in San Antonio, Tex., and observed numerous specimens flying about electric lights. He collected eight males and eight females and shipped them to the laboratory, one male and one female being dead on arrival September 29.

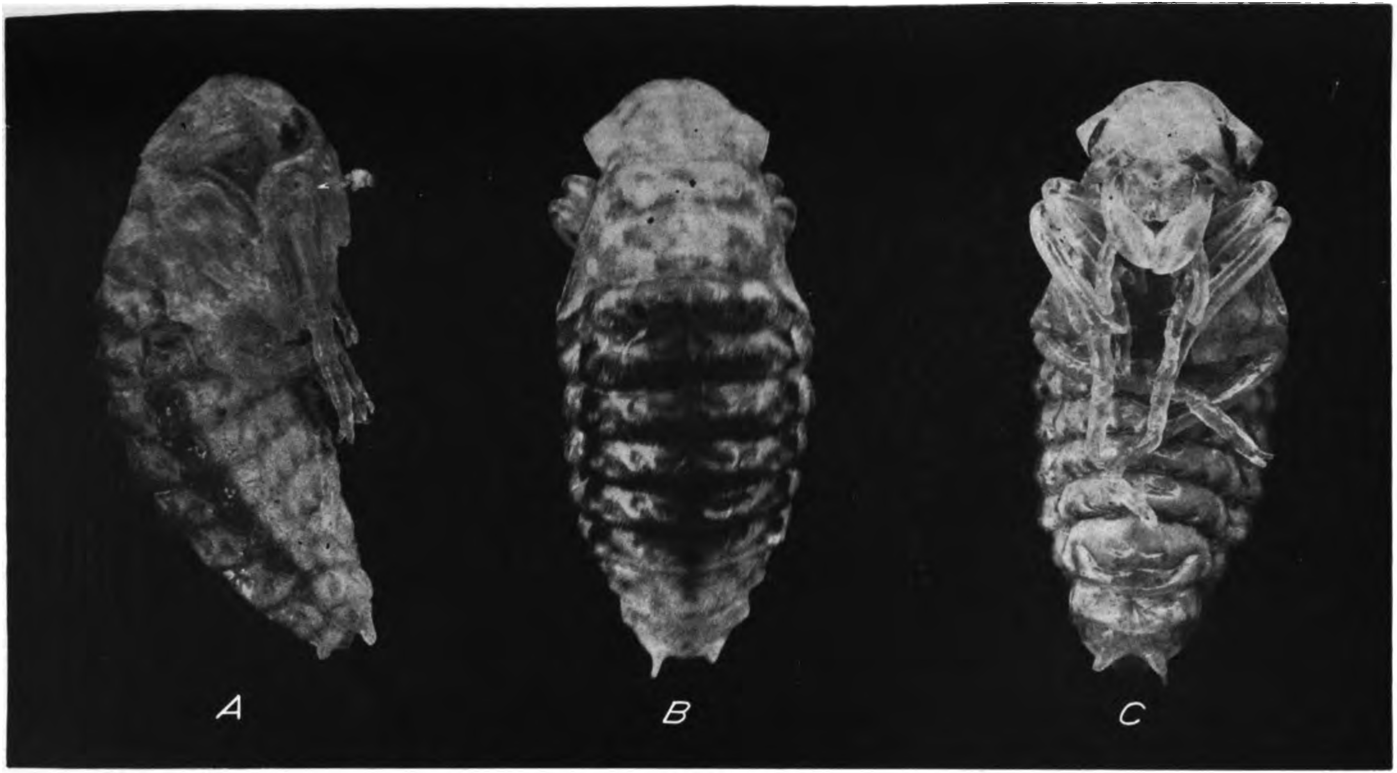
June 19 and July 6, 1910, 15 males and 19 females were received at the laboratory from Prof. C. E. Sanborn, Stillwater, Okla. August 29 of the same year 1 female was received from Mr. W. M. Orr, Manhattan, Kans.

April 26, November 11, and November 13, 1911, a total of 29 males and 47 females was received from Dr. Hunter and Mr. J. D. Mitchell from Dallas and Victoria, Tex. Between April 18 and 30, 1912, Mr. Mitchell collected and shipped from the latter point 103 males and 71 females.

The beetles were packed singly in pill boxes which were inclosed in pasteboard or cigar boxes and forwarded by mail. No food was supplied them en route and they arrived in excellent condition. These large collections show that the species is common at times in Texas and Oklahoma. Dr. Hunter on November 1, 1911, wrote Dr. L. O. Howard to the effect that they were seeing at that time an abundance of *C. lugubre* around arc lights at night and that it would be possible for a man to collect several hundred specimens at electric lights in an hour's time.

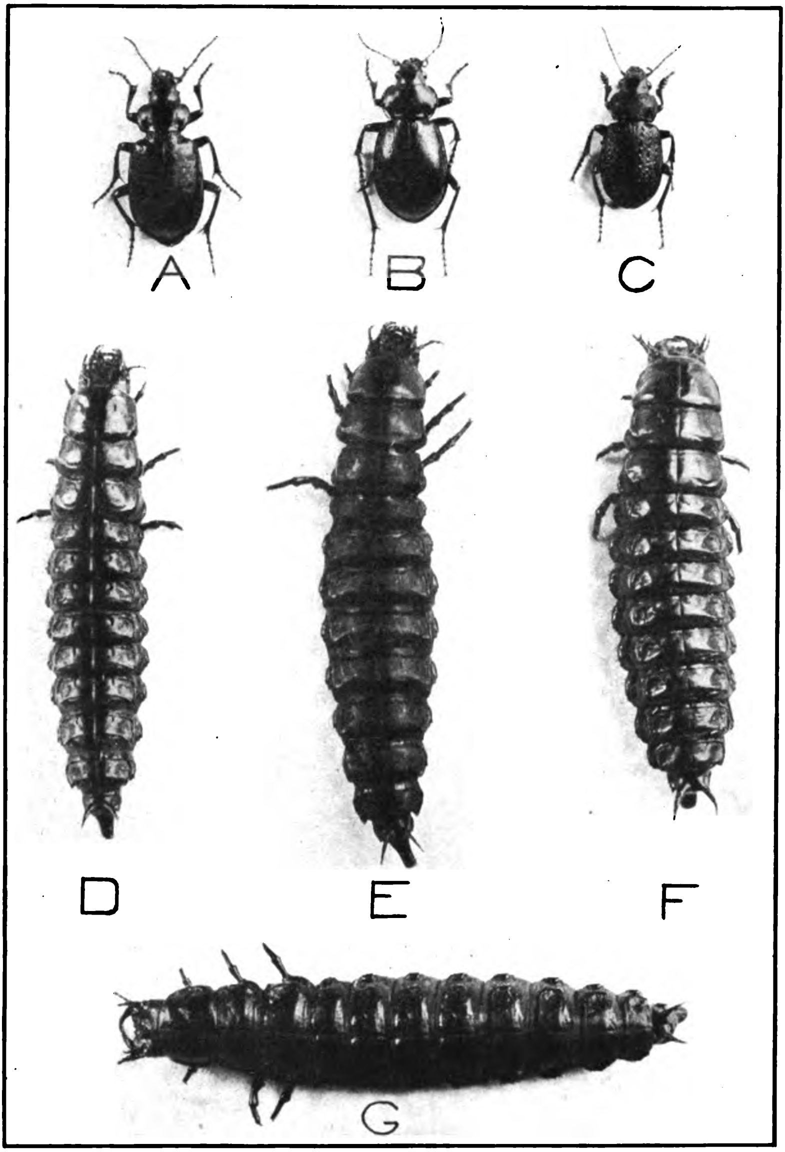
HABITS OF ADULTS.

Observations were made in 1911 and 1912 on the climbing habits of the adults, using the apparatus shown in Plate III. Adults were left inside the tin circle and were placed upon the bark of the tree several times between July 29 and August 2, 1911, and they would immediately descend. They proved to be rather clumsy and would fall in most cases before reaching the base of the tree. When the cage was visited the beetles were usually found buried in the earth at the base of the tree.



CALOSOMA RETICULATUM.

A.—Pupa, lateral view, ×4. *B*.—Same, dorsal view. ×4. *C*.—Same, ventral view, ×4. (Original.)



SPECIES OF CALOSOMA AND THEIR LARVÆ.

A.—Calosoma obsoletum: Adult. *B.—Calosoma haydeni:* Adult. *C.—Calosoma cancellatum:* Adult. *D.—Calosoma obsoletum:* Third-stage larva. *E.—Calosoma haydeni:* Third-stage larva. *F.—Calosoma semilaeve:* Third-stage larva. *G.—Calosoma cancellatum:* Third-stage larva. *A–C*, about natural size; *D*, *F*, ×2½; *E*, ×2⅓; *G*, ×3. (Original.)

November 14, 1911, 6 males and 14 females were liberated in the beds of *Asparagus plumosus* in Mr. Elliott's greenhouse, Brighton, Mass., by the junior writer, and several of these were placed upon the leaves of the plants. They did not show any ability to climb the smooth stems of asparagus but merely clung to the leaves for a few minutes and then dropped. Mr. Dudley, upon liberating adults in the same place and under the same conditions, April 19, 21, and 30, 1912, states that several of the adults thoroughly demonstrated their ability to climb these asparagus stems. The stems twine about strings arranged for their support in an upright position and some of the beetles which were placed upon them about 5 feet from the ground ascended 15 feet or more. A few of the beetles climbed to the top of these plants and down again without falling.

The data secured on the latter dates seem to indicate that this species would fare well under the conditions that existed in this greenhouse, as the cutworms (*Noctua clandestina*) climb to the top of these plants at night and feed on the young terminals.

FOOD CONSUMED BY ADULTS.

Some daily feeding experiments were conducted in the laboratory with adults received from Texas, September 29, 1909, and these gave interesting results. Such food as larvæ and pupæ of *Hyphantria cunea*, puparia of *Varichaeta* sp., and larvæ of *Carpocapsa pomonella*, *Plodia interpunctella*, *Pontia rapae*, and *Tenebrio molitor* were offered and were consumed greedily.

TABLE 21.—*Feeding record of three pairs of Calosoma lugubre, 1910.*

Species of full-grown larvæ consumed.	First pair.[1]	Second pair.[2]	Third pair.[3]
Malacosoma americana	13	....	....
Porthetria dispar	115	95	67
Estigmene acraea	20	14	7
Hyphantria cunea	48	....	....
Total	196	109	74

[1] Male emerged June 30, female emerged June 15; pair ceased feeding Sept. 10.
[2] Male emerged June 23, female emerged July 3; pair ceased feeding Aug. 10.
[3] Male emerged June 30, female was unearthed July 17; record was discontinued Aug. 10.

None of the above beetles reproduced in 1909 but fertile eggs were secured from the two latter pairs in 1910. All of these beetles died at the end of that year.

Two pairs of adults received from Victoria, Texas, April 26, 1911, were fed in jars from that date until the female of the first pair died August 11, and the other ceased feeding to enter hibernation at that time. Both pairs reproduced during the season, which usually stimulates the feeding activity. The first pair (No. 4764) consumed 44 full-grown *Noctua clandestina* larvæ, 106 sixth-stage *Malacosoma americana*, 121 fourth to sixth stage *Porthetria dispar* and 16 full-grown *Estigmene acraea* caterpillars with 6 *P. dispar* pupæ, making a total of 293. The second pair (No. 4765) consumed 46 full-grown *N. clandestina* and 30 *E. acraea* larvæ; 113 sixth-stage *M. americana* and 136 fourth to sixth stage *P. dispar* caterpillars with 43 pupæ of the latter species, making a total of 368. These two records well demonstrate the feeding capacity of this species.

STARVATION OF ADULTS.

April 26, 1911, one pair of beetles was placed in a jar of moist earth without food to ascertain how long they would live under such conditions. The male died May 8 and the female May 26, the former having lived eight days and the latter one month after receipt, in addition to four or six days in transit, during which time no food was furnished.

The beetles had probably fed before being collected about April 20 and the experiment merely indicates that the species could exist for a short time until migration could take place if, for any reason, the food supply became scarce or exhausted in a given locality.

REPRODUCTION.

Several specimens received September 29, 1909, from San Antonio, Tex., were kept in a warm room and they remained active and fed; one pair until December 23. No reproduction was secured with this lot in 1909 and two out of three of the females that lived to emerge from hibernation in 1910 deposited 30 and 36 fertile eggs, respectively. None of this lot of beetles lived to emerge in the spring of 1911.

One pair of adults received from Victoria, Tex., April 26, 1911, was placed in a jar for rearing records and between May 24 and August 11 deposited 141 fertile eggs. This is the highest total for one female of this species recorded at the laboratory. Another female received at the same time as the foregoing deposited only 10 fertile eggs between May 31 and June 26, 1911. Sixteen males and 20 females were kept in jars and cages for reproduction in 1911 but only about 5 of these females reproduced.

LONGEVITY.

Some of the adults that were received from Texas in the fall of 1909 did not die until after entering hibernation in 1910–11. During the winter of 1909–10 they hibernated successfully in the laboratory cellar but died the next winter on being forced to hibernate outside. These adults were pupæ in the fall of 1908 or earlier and were slightly over two years old at the time of death. There is no doubt that they would live at least three years in a warm climate.

HIBERNATION.

Beetles received at the laboratory September 29, 1909 (seven pairs), and kept in a warm room between October 4 and December 23, buried themselves in cavities at the bottom of jars in which they were fed. After cavities were made the jars were filled with earth and transferred to the cellar where they remained until spring. The temperature of the cellar during the winter ordinarily ranged from 40° to 60° F. but on cold nights it dropped below 32°. The following spring the jars were transferred to outdoor cages. The beetles emerged between June 15 and July 2 and one male was removed from a cavity at the bottom of the jar as late as July 6 and a female on July 17. Most of them went as deep as was possible for hibernation, as the jars contained only about 4 inches of earth at the time the beetles entered.

Seven males and 11 females received from Texas in 1911 were placed in outdoor hibernation cages after they ceased feeding in the fall. From the same lot of beetles three males and five females hibernated in jars in the cellar. None of those put in outdoor cages lived to emerge in the spring of 1912, while two males of those placed in the cellar emerged May 10. The dead beetles were unearthed ½ to 6 inches below the surface. The two that emerged from the jars were at the bottom, or under 6 inches of earth.

The results of these experiments indicate that this species can not successfully hibernate under New England conditions.

COLONIES.

In the fall of 1911 and during the spring of 1912 over 150 beetles of this species were colonized in a florist's greenhouse at Brighton, Mass. This is the same house in which experiments were conducted with *Calosoma scrutator* as an enemy of cutworms. Although many visits were made it was impossible to determine that reproduction took place. At the close of the experiment, December, 1912, no evidence was secured to show that this species can live through one year under greenhouse conditions in the North.

No attempts were made to colonize adults of this species in the field in New England on account of their failure to survive the winter. Very little is known of their habits in the South and Central West, but judging from the large numbers collected at various times and shipped to the laboratory, and what has been learned of their habits, they must destroy large numbers of lepidopterous larvæ that feed on and near the ground.

THE EGG.

Twelve fresh eggs gave the following average measurements: Length, 4.1 mm.; width, 1.6 mm. They are of the same elliptical form, ordinarily tapering slightly toward one end, as are those of other species of the genus. White with a very faint yellowish tinge.

Notes secured in 1910 and 1911 indicated that eggs deposited the latter part of July and August required four and five days to hatch.

DESCRIPTION OF LARVA.

First stage.—Small, rather stout, tapering abruptly to anal end. Average length of 20 specimens, 7 mm.; width, 1.6 mm. Caudal appendages short, stout, angled about 45° from the body, bearing a few short spines. Color dull black on the dorsum, ventral plates grayish brown. Lateral and ventral plates bearing numerous short spines.

Second stage.—Stout, tapering same as in first stage. Average length of nine specimens, 13.2 mm.; width, 3.1 mm. Caudal appendages very short, not erect, curved downward beyond dorsal protuberance. Dorsal protuberance very short, not prominent, making an angle of 45° with appendages. Color shining black on the dorsum, ventral plates very dark brown to black.

Third stage.—Robust in form. Average length of 12 specimens, 19.5 mm.; width, 4.9 mm. Caudal appendages similar to those of second stage but stouter, dorsal protuberance presenting same aspect, acute and located about two-thirds the distance from base to tip. Color dull to shining black on dorsum, ventral plates dark brown to black. No reddish-brown patch on dorsum of last segment in second and third stages.

TIME REQUIRED TO COMPLETE LARVAL STAGES.

The length of time spent in the larval stages varies considerably; 4 to 7 days are required for the first stage, 5 to 7 for the second, and 12 to 15 for the third, to date of pupation; 26 to 30 are required from date of hatching to pupation. One larva closely observed in 1912 transformed to the different stages as follows: Eggs hatched June 11; time in first stage 3 days; in second, 8 days; in third to date of pupation, 15 days; a total of 26 days. The larva ceased feeding July 3 and pupated July 7. Thus 4 days were required in making a cavity and passing through the prepupal stage.

FOOD CONSUMED BY LARVÆ.

Eggs of this species hatch so late in the season that it is sometimes difficult to find food for the larvæ in New England, as caterpillars and pupæ of *Porthetria dispar* are not available at that time.

TABLE 22.—*Food eaten by larvæ of Calosoma lugubre, 1911.*

Varieties of food consumed.	4767-J.	4565-A.	4565-C.	4565-F.	4565-G.	4565-K.	4565-L.
Estigmene acraea larvæ, full-grown	7	3	2	1	3	3	2
Estigmene acraea pupæ	....	5	2	1	....	....	4
Porthetria dispar pupæ	5	1	4	1	5	12	3
Pontia rapae larvæ, full-grown	3	....	4	4	2	2	3
Pontia rapae pupæ	1	5	....	....	....	....	....
Hyphantria cunea larvæ	2	7	3	9	19	5	4
Autographa brassicae larvæ, full-grown	....	....	2	....	3	4	1
Total	18	21	17	16	32	26	17

The larvæ hatched July 26 and August 6 and ceased feeding August 25, 26, and 28 and September 1, 2, and 12. Many of the larvæ and pupæ fed to them were small, as will be noted from Table 22, but the average number required to complete the growth of each was 21. Three similar records secured in 1912 averaged about the same, but larger caterpillars and pupæ were supplied during the time.

HABITS OF LARVÆ.

Data secured on the climbing habits of the larvæ of this species in the summer of 1911 gave negative results so far as they went.

Two first-stage larvæ were placed in the experiment (Pl. III) July 27 and 29. Neither attempted to climb the tree voluntarily but one when placed upon it crawled in and out of the crevices of the bark, neither ascending nor descending more than 2 inches before falling. It was again placed in the crotch of a limb and left for the night. It was found buried in the earth the following morning with no evidence that it had reached the food cage during the night. First-stage larvæ were repeatedly placed upon the tree with similar result.

Experiments with two second-stage larvæ indicated that they were able to climb very little.

August 8 a third-stage larva was placed upon the tree and in eight minutes climbed upward 2½ feet without stopping, then crawled under the bark. No further evidence of climbing was secured with third-stage larvæ. The actions of the larvæ in all stages were very similar to those of *Calosoma frigidum* and *C. inquisitor* and the indications are that they search for food on or near the ground.

PUPA.

Adults were reared from larvæ in 1911 and 1912 and notes were secured on the time spent in the pupal stage. From 2 larvæ that pupated September 4 and 12, 1911, 2 males issued as adults in 13 and 14 days, respectively. In 1912 two larvæ pupated July 7 and a female issued in seven days and a male in eight after pupation. The average mean temperature during the time the 1911 pupæ were in that stage, as taken from the Monthly Meteorological Summary issued from the United States Department of Agriculture Weather Bureau Office at Boston, Mass., was 63.5° F., while the average during the time the latter pair were pupæ in 1912 was 79° F. This accounts in a measure for the varying length of time spent in this stage. Seven and eight days are abnormally short pupal periods in comparison with those of other species of this genus.

The average length of the female pupa is 21.5 mm.; the width, 7.5 mm.; the male pupa is 17 mm. in length and 8.2 mm. in width.

Daily notes were made on the changes in appearance of three pupæ in 1911, and as these varied so little the notes on one (No. 4765–K) are given:

August 6. Egg hatched.

September 2. The larva ceased feeding and entered the earth for pupation.

September 12. Creamy white pupa observed in cavity at bottom of jar. Eyes light brown.

September 15. Eyes light brown, appendages and body still creamy white.

September 16. No noticeable change in pupa since the 15th.

September 18. Eyes changing to brownish-black. Aside from that no other noticeable changes in color of pupa.

September 19. Eyes black. No other definite change noted.

September 21. Eyes black, mandibles and tarsal claws brown. Anal segment of the abdomen and tibial joints also brown.

September 22. Mandibles brownish black, elytra yellowish brown.

September 23. Eyes and mandibles black, tibiæ and tibial joints almost black. Elytra yellowish brown. Tarsi light brown and claws dark brown.

September 24. Eyes, mandibles, and legs black, last segment of abdomen dark brown. Head and elytra yellowish brown; other segments of abdomen still light in color.

September 25. Male adult issued. External skeleton of beetle still soft, but has its natural color.

Thirteen days were required for completion of the pupal stage, and the beetle died later after being put into a hibernation cage.

EXPERIMENT TO DETERMINE RELATIVE PROPORTION OF CATERPILLARS CONSUMED DURING DAY AND NIGHT, 1912.

During the spring of 1912 two jars of adults, each containing two pairs, were used in this experiment. One jar (No. 5824–A) was supplied with food at 8 a. m. and the count of the number of cutworms (*Noctua clandestina*) eaten was taken at 5 p. m. and those remaining were removed until the following morning, when a new supply was added. Thirty-one full-grown cutworms were eaten during the days between May 4 and 24. Cutworms were supplied the other jar (No. 5824–B) at 5 p. m., when it was transferred to a dark closet until 8 a. m. The jar was then removed from the closet, the number of cutworms eaten noted, and those remaining were removed until 5 p. m. This operation was repeated from May 4 to 24, and 64 full-grown cutworms were consumed during the nights.

The experiment merely shows that these beetles feed either by day or by night, as circumstances may require. More cutworms were consumed by the beetles fed at night than by those fed during the day, but the probable reason was that the day-record jar was kept in the outdoor cage and the weather was quite cool, while the other jar was kept in a closet in the laboratory at night, where it was much warmer.

Similar experiments were tried with the larvæ of this species and it was found that they also feed during both day and night.

BIBLIOGRAPHY.

1853. LECONTE, J. L. Notes on the classification of the Carabidæ of the United States. *In* Trans. Amer. Phil. Soc., v. 10, n. s., pt. 3, art. 27, p. 364–403.

Page 400. Original description of *Calosoma lugubre.*

1881–1884. BATES, H. W. Biologia Centrali-Americana, v. 1, pt. 1, 316 p., 13 pl.

Pages 21, 262. Note to the effect that *C. peregrinator* Guér. resembles more closely *C. lugubre* Lec. than *C. prominens* Lec.

1890. BRUNER, L. Insects Injurious to Young Trees on Tree Claims. Univ. Nebr. Bul. 14 (Bul. Agr. Expt. Sta. Nebr., v. 3, art. 2), p. 83–149, 98 fig.

Page 117. Note of this species and *C. externum* being attracted to lights and their feeding upon May beetles.

CALOSOMA PALMERI Horn.

ORIGINAL DESCRIPTION.

Black, shining. Body feebly winged. Antennæ piceous, fourth joint slightly shorter than the fifth. Mandibles sparsely punctured with coarse and fine punctures intermixed. Head nearly smooth, with scarcely visible transverse wrinkles and very minute punctures. Thorax nearly twice as wide as long, base broader than the length and not emarginate, sides moderately arcuate and converging posteriorly, margin very narrow, not reflexed, hind angles obtuse, basal impressions moderately deep, median line very fine; surface extremely finely transversely wrinkled, and with very few punctures near the basal margin: elytra obovate, humeri broadly rounded, sides moderately arcuate, disc moderately convex, obsoletely substriate, striæ very indistinctly punctured, intervals 4–8–12 with very distinct larger punctures. Body beneath black, shining, smooth or obsoletely transversely wrinkled. Length .74 inch; 19 mm.

Male.—Anterior tarsi with three joints dilated and pubescent, fourth joint glabrous. Length 19 mm. Guadalupe Island, Cal.

Following this description,[1] Horn says:

> This species should be referred to the same group with *triste*, etc. (Group iv., Lec. Proc. Acad. 1862, p. 53) from all the species of which it differs by the thorax being narrowed behind and the base narrower at the apex; the elytra are also obovate in the present species and oblong oval in all the others. The body in *Palmeri* is feebly winged, and in the others (except *Haydeni*) the wings are fully developed. In the latter species the elytra are connate, and I have been unable to detect traces of wings.
>
> Numerous specimens were collected on Guadalupe Island by Dr. Edward Palmer, to whom I take great pleasure in dedicating it. Specimens were sent by me to my friend, M. Aug. Sallé, of Paris, who informs me that there is nothing in the fauna of Mexico with which it may be compared.

Aside from the locality just mentioned, this species occurs in California and Mexico.

CALOSOMA TRISTE Lec.

ORIGINAL DESCRIPTION.

Black, elytra very indistinctly striate and punctate, with three rows of larger impressed punctures.

Habitat: Territory of Missouri.

Ovate, somewhat elongated, with posterior somewhat convex, black. Head punctate anteriorly, minutely rugose posteriorly with impressions lightly marked, arched posteriorly. Thorax lightly corrugated and punctate, with punctures larger towards the base; emarginate anteriorly, sides rounded, lightly depressed posteriorly; posterior angles extending below the quite even base; no impressions anteriorly, lightly marked posteriorly; lines indistinct longitudinally, with basal impressions regular, deeply punctate. Elytra obsoletely punctate, and striate, with a few transverse grooves, quite indistinct; with small shallow punctures, also three impressed series of punctures on the interstices.

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[1] Horn, G. H. Notes on the coleopterous fauna of Guadalupe Island. *In* Trans. Amer. Ent. Soc., v. 5, p. 198–201 (p. 199), 1874–1876.

Calosoma indistinctum, Say, (which is described by Count Dejean under the name *luxatum*) quite agrees, but is larger and elongated. Striæ and elytral pits scarcely conspicuous; moreover the pits of *C. indistinctum* are blackish-blue.

DISTRIBUTION.

LeConte published the foregoing description in 1845, and since that time the species has been recorded from Arizona, Arkansas, California, Colorado, Kansas, Nebraska, and New Mexico. F. H. Snow reports having taken specimens at an altitude of 3,750 feet in Cochise County, Ariz. The species is known to occur in Mexico.

BIBLIOGRAPHY.

1845–47. LeConte, J. L. Descriptions of some new and interesting insects inhabiting the United States. *In* Boston Jour. Nat. Hist., v. 5, p. 203–209.

Page 208. Original description of *C. triste* with habitat notes in the territory of Missouri.

1845. LeConte, J. L. Descriptions of new Coleopterous insects in the United States. *In* Boston Soc. Nat. Hist., v. 1, p. 201.

1877. Popenoe, E. A. A list of Kansas Coleoptera. *In* Trans. Kansas Acad. Sci. f. 1876, v. 5, p. 21–40.

Page 22. "Western Kansas."

CALOSOMA OBSOLETUM Say.

[Pl. XVII, *A*.]

(Syn.: *C. luxatum* Dej.)

ORIGINAL DESCRIPTION.

Brownish-black; elytra reticulated and with three series of impressed bluish spots.

Habitat: Arkansas.

Body brownish-black; mandibles rugose and convex on the superior surface; thorax obtusely and minutely rugose, impunctured; region of the posterior angle indented; an abbreviated impressed dorsal line; posterior angles rounded, extended backward a little beyond the basal line; elytra reticulate; longitudinal lines slightly impressed, not more dilated than the transverse ones, which are mostly continuous, their points of intersection marked by a puncture; three series of impressed bluish or violaceous obscure spots on each elytron; lateral margin in a certain light very obscurely purplish.

Length seven-tenths of an inch.

Found near the Rocky Mountains.

EARLY RECORDS AND DISTRIBUTION OF THE SPECIES.

This species was first described by Thomas Say in 1823. Dejean, in 1826, described *Calosoma luxatum*, which was later found by Dr. LeConte to be a synonym of *Calosoma obsoletum* Say.

It has been collected in the following States: Colorado, "Dakota," Kansas, Montana, Nebraska, New Mexico, Texas, and Utah. It has also been reported from the Northwest Territory in Canada.

COLLECTIONS AND SHIPMENTS.

The data included on this species were secured in New Mexico by members of the scientific staff under the cereal and forage insect investigations of this bureau in connection with the New Mexico range caterpillar (*Hemileuca oliviae* Ckll.). Mr. D. J. Caffrey planned and executed many of the experiments and, through the late Prof. F. M. Webster and Mr. W. R. Walton, acting in charge, Cereal and Forage

Insect Investigations, and Mr. V. L. Wildermuth, their notes were kindly placed at the writers' disposal.

October 11, 1915, there were received at Melrose Highlands, Mass., 11 males and 6 females living and 1 female dead from Mr. Caffrey. These were shipped from Maxwell, N. Mex. They were inclosed in jars and offered larvae of *P. rapae*, upon which some of them actively fed until November 1 before entering hibernation. They are still in hibernation at this writing (April, 1916). Many specimens were collected on the range between May and August, 1913 to 1915, and their habits studied in connection with the range caterpillar at Koehler, N. Mex.

FOOD CONSUMED BY ADULTS.

During the summers of 1913 and 1914 adults were collected on the range and one pair each inclosed in battery jars containing earth and records kept daily of the amount of caterpillars consumed and reproductive habits. The beetles were very numerous at Raton, N. Mex., in 1913, and 15 pairs were collected for rearing experiments. Several pairs fed from July 28 (date collected) until September 4 consumed 75, 65, 61, 57, 56, and 55 *Hemileuca oliviae* Ckll. larvæ, respectively, before being transferred to hibernation cages. The beetles proved themselves readily predacious on the above species, having averaged destroying approximately two caterpillars per day during the period. Those fed in confinement in 1914 devoured *H. oliviae* larvae from May 29 to September 5, proving predacious on this species throughout, but only to a slight extent after the middle of August. After that time the beetles were inactive and spent much of their time beneath the surface of the soil.

Both adults and their larvae were observed destroying the pupae of *H. oliviae* in their cocoons, but this particular stage of the host insect was destroyed more commonly by the beetle larvæ than by the adults.

REPRODUCTION AND HIBERNATION.

The females in confinement and under observation at the laboratory, Koehler, N. Mex., during 1914 deposited eggs, beginning the first week in June and ceasing about the first week in August. The eggs hatched in from six to nine days. One female, during this season, deposited 60 fertile eggs between June 8 and 17; one, 31; and another, 19. The latter female deposited eggs between July 13 and August 1. As is indicated by these records, the propagating and feeding season of the adults and feeding period of the larvæ extends over a long season, which approximates the growing period covered by the larval and pupal stages of *H. oliviae*.

The adults become more or less inactive after the middle of August to September 1 in the field and soon seek hibernation in the ground. Twenty-five beetles under observation, fed in cages in 1913, were transferred to hibernation cages September 4. The last of this lot entered the ground October 12. Their first appearance in the field was noted May 26, 1914, indicating the approximate time of first emergence. Those kept in jars containing 5 to 6 inches of loose soil at Melrose Highlands, Mass., fall of 1915, descended to bottom of jar to make cavities for hibernation.

The maximum length of life of adults of this species has not been definitely determined, but it is probable that they live two or three years.

FIELD OBSERVATIONS AND ECONOMIC IMPORTANCE.

Mr. C. N. Ainslie of this bureau under date of August 26, 1914, observed a number of adults of this species in alfalfa fields infested by *Loxostege* sp. at Friend, Nebr. The beetles were moving about rapidly, so he did not see them feeding. One specimen was taken for determination.

May 26, 1914, Mr. T. S. Wilson of this bureau collected the adults of this species on the ranges in New Mexico as early as May 26 in 1914. During the week of June 10 the specimens were showing up quite commonly. June 17 Mr. Caffrey states that the adults were noted to be present in abundance. Approximately 25 or 30 were seen in one-half hour. Hemileuca and Malacosoma larvæ were abundant in the vicinity. August 9 several of the beetles were observed on the slopes of Eagle Tail Mountain, N. Mex.

Mr. Walton and others observed the beetle larvæ feeding upon caterpillars and pupæ of *H. oliviae* in the field, the beetle larvæ seizing its prey in the usual manner for Calosoma in general and holding on until the caterpillar is subdued and a puncture effected with the mandibles. The body contents then ooze out in part and the beetle larva feeds until its appetite is satiated. In one instance, an adult beetle was noted feeding upon a male Hemileuca moth.

The beetles and their larvæ were found in practically all parts of a range infested with *H. oliviae* Ckll. but were noted more commonly near wooded areas. The adults and larvæ were noted feeding on pupæ of *H. oliviae* through the coarse meshes of the cocoon. These cocoons and pupæ were often located in weeds and grasses from 2 to 6 inches above ground and the fact that the beetle larvæ had found their prey in these situations indicates their ability to climb and their importance as an enemy of such a caterpillar pest.

Mr. H. F. Wickham conducted some investigations with this species along with *C. haydeni* Say by supplying both killed and living grasshoppers along with *H. oliviae* larvæ as food for the beetles to determine their preference with reference to accessibility of same. The results were similar for each species of beetle and are recorded under *C. haydeni* Say.

BRIEF DESCRIPTION OF LARVA.

First stage. Rather slender larva. Average length of five newly-hatched specimens that had been preserved in alcohol, 10 mm.; width, 1.9 mm.; color, black dorsally, ventral plates grayish-brown. Ventral plates ordinarily containing one and two long brown hairs and sometimes other shorter ones. Caudal appendages rather stout (1.3 mm. long), slender, projecting obliquely backward.

Second stage. Form similar to first stage. Average length of six specimens, 16.6 mm.; width, 3 mm. Caudal appendages bearing short acute protuberance dorsally beyond middle on each and curving slightly downward beyond these. Dorsum shining black and ventral plates dark brown in this stage.

Third stage (Pl. XVII, *D*). Rather slender larva. Average length of five almost mature specimens, 26 mm.; width, 4.6 mm. Caudal appendages rather stout (1.3 mm. long) and erect, curving backward after dorsal protuberance. Appendages widely separated at base, tapering to a point abruptly beyond dorsal protuberance, which is located about two-thirds the length of each appendage. Color shining black above, dark brown below. Ventral plates sparsely clothed with hairs. Anterior ventral plates 2 to 7, inclusive, oval in form, dilated in middle, sometimes notched posteriorly in the center, also containing a small median keel more prominent near the posterior margin. Posterior angles of anal segment narrow at base, slightly turned upward into a long blunt point with stout spine at apex. Posterior angles of tergite of penultimate segment projecting backward rather pointedly.

LARVAL RECORDS.

Many larvæ were reared in jelly glasses during 1913 and 1914 by Mr. D. J. Caffrey at the Koehler, N. Mex. laboratory, and both larvæ and pupæ of *H. oliviae* were consumed by them. Upon approaching maturity they were transferred to cages for pupation. Larvæ hatching June 10 and 16, respectively, remained active and fed until about July 2 to 10 before entering the ground for pupation. More Hemileuca larvæ are ordinarily destroyed at this season by each Calosoma larva when they are smaller than when the caterpillars are approaching maturity.

The average time required to pass the first larval stage was 6 days; for the second, 6, and for the third to date ceased feeding, 8. Additional to this, from 3 to 6 days are passed in the prepupal stage, thus totaling 20 to 26 days in the larval stages to period of pupation. The larva in the last few days makes an oblong-oval cell in the earth where the pupal stage is passed.

PUPA.

Two rather undersized specimens reared at Koehler, N. Mex., measured 15 mm. long and 7 mm. wide for the male and 18 mm. long and 8 mm. wide for the female. The head is folded back under the thorax, and wings folded over ventral side. The first five abdominal segments are clothed with very short hairs dorsally, dorsal surface of remaining segments smooth. Color, creamy-white.

Seven of the larvæ bred in New Mexico in 1914 went through the pupal stage and emerged as adults. From 3 to 6 days were passed in the prepupal stage and about 12 in the pupal. These larvæ like other species of the genus pupate in cavities in the earth.

BIBLIOGRAPHY.

1823. SAY, THOMAS. Descriptions of Coleopterous insects collected in the Expedition to the Rocky Mountains. Journ. Acad. Nat. Sci. Phila. T. 3, p. 149.

Original description of *Calosoma obsoletum*. Specimens collected near the Rocky Mountains, also inhabits Arkansas.

1826. DEJEAN, M. le Comte. Species général des Coléoptères de la collection de M. le Comte Dejean, T. II, p. 96.

Description of *C. luxatum* which Dr. Le Conte later threw into synonymy with *obsoletum* Say.

1877. POPENOE, E. A. A list of Kansas Coleoptera. Trans. Kans. Acad. Sci., vol. 5, p. 22.

Page 22. "Topeka and Lawrence."

CALOSOMA SEMILAEVE Lec.

ORIGINAL DESCRIPTION.

Black, without luster, face intricately punctate, with thorax intricately punctate, more heavily back of the middle; much wider than long, with sides quite rounded, margin somewhat reflexed at the base no less than at the apex, marked with two indentations on each side, with elytra finely punctate in series, punctures large on the anterior, interstices with imbricated grooves up to the middle.

Length 0.85. Single specimen, San Jose, Cal. I have found elytra of another at San Diego, Cal.

This species was described by Dr. LeConte in 1851,[1] his type specimen being taken in San Jose, Cal. Collection data on the species in later years records it as occurring in many points in California south of San Francisco and in Camas, Idaho. Its range probably extends over a somewhat larger territory than is here represented.

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[1] Le Conte, J. L. Description of new species of Coleoptera from California. *In* Ann. Lyc. Nat. Hist. N. Y. f. 1851, v. 5, p. 125–216, 1852.

COLLECTIONS AND SHIPMENTS.

April 7 and 27, 1911, the late Mr. H. M. Russell of this bureau collected and shipped from Hollywood, Cal., 5 males and 8 females of this species to the laboratory at Melrose Highlands, Mass. They were collected under pea vines feeding upon larvæ of *Peridroma saucia* Hübn. Mr. P. H. Timberlake, also of this bureau, collected and mailed to the laboratory from Whittier, Cal., 1 female which was dead on arrival May 27, 1911. Mr. J. E. Graf collected in Compton, Cal., April 5 and 6, 1914, on low shrubbery 5 males and 12 females and forwarded them to Melrose Highlands, Mass. He reported them feeding on coleopterous and lepidopterous larvæ.

HABITS OF ADULTS.

June 9, 1911, one pair of beetles was liberated inside of the tin circle in the center of which stood a section of a white-oak tree (see Plate III). They first traveled around the circle for some time and did not attempt to climb. They were then placed upon the bark of the tree and immediately proceeded to descend. At another time when they were put upon the tree, they climbed slowly and steadily to the top. The female climbed out on a small twig one-eighth of an inch in diameter and 12 inches long, hanging on the underside. On reaching the end she fell.

These experiments and the findings of Mr. J. E. Graf cited under the previous subject (as having taken the beetles on low shrubbery) indicate that they do climb to some extent. Their habits compare in a measure to those of *C. frigidum* Kirby.

FOOD CONSUMED BY ADULTS.

Feeding records were kept of beetles confined in two battery jars during the spring and summer of 1911. May 3 the beetles were received from Hollywood, Cal., and were fed cutworms (*Noctua clandestina* Harr.) until June 27. Two males and 5 females were placed in the two jars and 37 fifth and sixth stage *P. dispar* caterpillars and pupæ were consumed in about 15 days after the records were started. Two males and 2 females died between July 7 and 18 and the remaining females ceased feeding by August 2 and descended in the jars for hibernation.

One pair of adults from California, April, 1914, were offered *N. clandestina* larvæ after receipt, of which they consumed from 7 to 12 per day for a period of 3 weeks. *M. americana* larvæ were later consumed until about June 1, when the beetles began to remain inactive at the bottom of the jar.

The beetles were most active during April and May, at which time it was difficult to secure sufficient caterpillars for food.

REPRODUCTION AND HIBERNATION.

Three males and 8 females were kept under observation in three jars at the laboratory during the summer of 1911. All of these died during the summer except 3 females that entered hibernation about

July 19 and August 3. No eggs were secured from any of the females notwithstanding the fact that the collector saw one pair in copulation April 27 at Hollywood, Cal., the day they were shipped.

The three females that entered hibernation in outdoor cages during the summer of 1911 were found dead and dismembered 3 and 4 inches below the surface of the earth in the spring of 1912. It is very probable that this species is not adapted to withstand New England winters.

Of the lot of adults received from California April, 1914, two pairs were enclosed in one jar in which eggs were found May 15 and June 5. One of these females died before eggs were deposited, and 69 larvæ hatched as a total from one female. June 18 a few infertile eggs were deposited on the surface of the earth in a jar which contained 1 male and 4 females at the time.

None of the adults lived to enter hibernation that fall.

EGG.

Nine eggs that had been preserved in alcohol averaged 4 mm. in length and 1.7 mm. in width. Color white, form elliptical, tapering slightly toward anal end in those containing fully developed embryo.

Sixty-nine eggs deposited by one female in 1914 between May 11 and June 5 hatched in from 6 to 13 days.

BRIEF DESCRIPTION OF LARVA.

First stage.—Small robust larva. Average length of 6 newly-hatched specimens that had been preserved in alcohol, 8 mm.; width, 2.2 mm. Color dark brown dorsally, ventral plates grayish brown. Ventral and lateral plates especially thickly set with long brownish hairs. Caudal appendages (1.3 mm. long) very slender.

Second stage.—Form similar to first stage. Average length of 3 specimens (almost ready to molt) 18.5 mm., width 3.2 mm. Caudal appendages rather long and pointed with several protuberances bearing spines, the middle dorsal being slightly more prominent than others. Color of dorsum dark brown to black, ventral plates brown.

Third stage (Pl. XVII, *F*).—Short robust larva. Average length of 4 specimens 24.5 mm., width 5.7 mm. Caudal appendages rather long (1.8 mm.), diminishing abruptly in size after middle. Dorsal protuberance on middle of each appendage rather long, acute, extending backward, parallel with caudal appendage. Appendages show slight curve downward beyond middle, tapering to a short point. Color shining black above, grayish brown below. Ventral plates thickly set with hairs, regular in outline. Anterior ventral plates on abdominal segments 2 to 7, inclusive, oval in form and somewhat dilated, without regular marginal notches. Posterior median plates rectangular in form and outer ventral plates on 3d to 7th abdominal segments oval. Posterior angles of anal segment narrow at base, projecting straight backward into a long blunt point with stout spine at apex.

LARVAL RECORDS.

Many larvæ were reared in individual jars during 1914 and were fed *M. americana* larvæ which were very easy to obtain during May and June. It was estimated that from 20 to 35 large caterpillars were destroyed by each beetle larva before maturity, as actual counts were not made in connection with this species.

The larvæ are active and feed over a period of from 18 to 25 days, or an average of 23. Time required to complete the various stages in an outdoor vivarium at the laboratory, as averaged from 7 specimens, was 5 days for the first, 4 for the second, and 14 for the third up to the time the larvæ ceased feeding. An additional period of from 4 to 6 days elapsed before the larvæ pupated.

HABITS OF LARVÆ.

During June, 1914, some observations were made on the climbing habits of the larvæ at the laboratory (Plate III) and it was found that the very young individuals were inclined to do this to some extent, one specimen having climbed up the white oak post 6 feet, then out on stovepipe wire and back to post before falling. Second-stage larvæ did not show an equal ability in this respect, and third-stage larvæ were not tried, owing to a limited amount of material.

It is rather difficult to estimate from these limited observations to what extent this habit prevails in the field, which is indicated by the habits of the host insect upon which this predator most commonly feeds.

PUPA.

Two male pupæ were preserved in alcohol from the rearings of 1914, the average measurements of which were 18.5 mm. in length and 8.2 mm. in width. Several larvæ pupated and were reared through to maturity.

Notes were made on the changes of color and development of one pupa found in cavity at bottom of jar July 5 and transferred to surface of earth. The pupa was creamy white, the mouth parts and tarsi after about five days beginning to turn brown. This color darkened with age and later the tibiæ began to show brown. After nine days the thorax and abdomen had changed gradually to brownish black. Legs brownish black at that period. July 18, the pupa died just as it was about to mature.

BIBLIOGRAPHY.

1851. LeConte, J. L. Ann. Lyc. Nat. Hist. New York, v. 5, p. 199.
Original description of the species.

1915. Essig, E. O. Injurious and Beneficial Insects of California.
Supplement to Monthly Bull., Cal. Hort. Com., Vol. IV, No. 4, p. 217. Account of life history and habits.

CALOSOMA SIMPLEX Lec.

ORIGINAL DESCRIPTION.

Black, subopaque. Head and prothorax finely rugose and punctulate, the latter more than twice as wide as long; sides strongly margined, rounded in front, oblique behind, more widely reflexed towards the base; base bisinuate, broadly rounded at the middle, hind angles distinctly prolonged, broadly rounded; basal impressions large and deep; dorsal line fine. Elytra slightly wider than the prothorax, oblong, oval, convex towards the sides, which are narrowly margined towards the base and more widely so along the sides; near the base are seen four small acute teeth, as in our allied species; striæ not impressed, composed of extremely fine punctures; the punctures of the three dorsal rows are also small and not conspicuous; interspaces alutaceous, not distinctly rugose. Tibiæ straight.

Length 20.5 mm. Middle California, one male.

DISTRIBUTION.

This species was described by LeConte in 1879,[1] the type specimen, which was a male, having been taken in California. It has been reported from Arizona, California, Colorado, and Texas. It has also been taken in Mexico.

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[1] LeConte, J. L. Description of a new species of Calosoma. *In* Bul. Brooklyn Ent. Soc., v. 1, no. 8, p. 61-66, 1878.

CALOSOMA HAYDENI Horn.

[Pl. XVII, *B*.]

ORIGINAL DESCRIPTION.

The above name is proposed for a species in which the first three joints of the anterior tarsi of the male are spongy pubescent beneath, the base of the thorax truncate. It is therefore allied to our *triste* and *obsoletum*, but differing from them in having the elytra connate and body apterous. The head is large, as in *triste*, and the frontal impressions deep, rather finely punctured and wrinkled; vertex with but few punctures, occiput smooth. Thorax as in *triste*, but with the basal impression deeper and the lateral margins at base more strongly reflexed, nearly as much as in *semilaeve*. Disc with distinct coriaceous sculpture and feeble median line, margins coarsely but distantly punctured, becoming more dense near the hind angles and basal region. Elytra elongate oval, humeri strongly rounded, and as distinctly margined as the sides. Surface very convex in both directions and with striae of fine distinct punctures feebly impressed. Basal region with distant submuricate punctures. Margins distinctly muricately punctured, more dense at the humeral region, almost disappearing at the apex. Metathoracic parapleurae and sides of abdomen with coarse punctures. Its color above and beneath is shining black.

Length 0.84 inch; 22 mm.

Collected in southern Colorado by C. Thomas, of the U. S. Geological Survey, under Dr. F. V. Hayden.

DISTRIBUTION.

This species was described by Dr. Horn in 1870.[1] The type specimen was collected in southern Colorado. There are also other later reports of its being taken in Colorado, Arizona, and New Mexico.

COLLECTIONS AND SHIPMENTS.

The data included on this species were secured in New Mexico by members of the scientific staff under the Cereal and Forage Insect Investigations of this Bureau in connection with the New Mexico Range Caterpillar (*Hemileuca oliviae* Ckll.). Mr. D. J. Caffrey with the assistance of others conducted the life-history studies and through the late Prof. F. M. Webster and Mr. W. R. Walton, the notes were secured for publication here.

October 16, 1915, there were received at Melrose Highlands, Mass., from Mr. Caffrey at Maxwell, N. Mex., 7 males and 5 females, living. These were packed in damp sphagnum moss and arrived in good condition. They were placed in battery jars and fed larvæ of *P. rapae*. One pair remained more or less active until November 2 in Massachusetts and consumed 22 of the above larvæ before entering hibernation. They are still in hibernation at this writing (April, 1916).

FOOD CONSUMED BY ADULTS.

July 28, 1913, 2 males and 1 female were collected in the field and enclosed in a battery jar. They were offered plenty of *H. oliviae* larvæ and pupæ during the season of which they consumed 114 of the larvæ up to September 13. They were offered the pupæ after this date but refused. Weather conditions changed to cold and windy and the beetles sought hibernation soon after. In another jar containing the same number of adults, 102 Hemileuca larvæ and no pupæ were consumed. The beetles in cages in 1914 proved predacious on *H. oliviae* larvæ and fed from June 8 to September 3, the number destroyed each day gradually decreasing until toward the end of

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[1] Trans. Amer. Ent. Soc., Vol. 3, 1870, p. 69.

August feeding practically ceased, the beetles spending most of their time in the earth in the jar.

Mr. H. F. Wickam conducted cage experiments at Koehler, N. Mex., in August, 1914, to determine if the beetles would kill and eat grasshoppers and *H. oliviae* caterpillars and if preference was shown. The experiment was started August 10 and both varieties of living prey were supplied. In one cage under observation 33 days, 33 large *H. oliviae* larvæ and two grasshoppers were killed and eaten and in another cage containing 3 beetles under observation 15 days, 6 caterpillars and 1 grasshopper were killed and eaten. Some contrasting experiments were conducted at the time where killed grasshoppers were supplied the beetles with living *H. oliviae* caterpillars and as a result many more of the former were consumed than of the latter. Dead caterpillars were not eaten so readily as living. These experiments indicate that accessibility to a particular host is the important factor in the partial control by a predator. Practically the same results were secured in like experiments with *C. obsoletum* Say.

REPRODUCTION AND HIBERNATION.

Two males and 1 female in breeding jar from July 28 to September 13, 1913, deposited at least 6 eggs, 3 of which hatched. Copulation was observed several times during the season. In another jar containing the same number of adults, 18 eggs were deposited, 15 of which hatched. The first eggs were deposited by beetles in confinement in 1914 on June 9 and the last August 4. In one cage containing more than one female, 156 larvæ hatched and in another 162 hatched. The time in the egg stage varied from 7 to 12 days.

The first adults issued from hibernation in New Mexico in 1914 on or before June 5 and adults were seen in the field up to September 2 and even October 10, the latter dates indicating the late periods of entering hibernation. One beetle remained on the surface of the earth in a jar at Melrose Highlands, Mass., as late as October 20, 1915. They went into the soft earth to the bottom of the jar, a depth of 5 to 6 inches, for hibernation.

The maximum length of life of adults of this species has not yet been determined but they undoubtedly live 2 years or more.

FIELD OBSERVATIONS AND ECONOMIC IMPORTANCE.

June 5, 1914, one female was collected near Dorsey Reservoir and on the same date Messrs. W. R. McConnell and T. S. Wilson collected a large number to the south of Koehler, N. Mex. The beetles were found under rubbish, in the bed of a dry creek. Hemileuca larvæ were present in the vicinity but were not very numerous. June 28, 1915, Mr. D. J. Caffrey observed north of Maxwell, N. Mex., a female of this species feeding upon a second-stage larva of *H. oliviae* Ckll. and in the region of Chico on September 2 observed a larva of this species or *obsoletum* Say feeding upon a partly formed pupa of the same host.

The adults were observed in the field in New Mexico in common with *C. obsoletum* Say at periods from June 5 to about October 10, always associated with its host, *H. oliviae* Ckll., and apparently accomplishing a great deal in the natural control of the above pest. Mr. Caffrey observed the beetle larvæ feeding upon Hemileuca pupæ.

Generally the anal end of the beetle larva was seen protruding through the meshes of the Hemileuca cocoon which indicated what was happening inside. Upon closer examination it was found that the Hemileuca pupa was being destroyed. These pupæ attacked were located 5 to 6 inches above ground, generally in Gutierrezia plants, demonstrating the ability of the larvæ to climb for their prey. Adults were also noted feeding upon the pupæ to a small extent.

BRIEF DESCRIPTION OF LARVA.

First stage.—Long, rather slender larva. Average length of 5 newly hatched specimens that had been preserved in alcohol, 10.3 mm.; width, 2.1 mm. In very young larvæ head and thorax dull black and abdomen brownish-black above and grayish-brown below. Ventral plates ordinarily containing from 1 to 3 long brown hairs and sometimes other shorter ones. Caudal appendages long (2 mm.), straight, projecting obliquely backward.

Second stage.—Form similar to first stage. Average length of six fairly large specimens, 19.6 mm.; width, 3.2 mm. Caudal appendages long, straight, bearing short, acute protuberance dorsally in middle. Appendages continuing almost straight after dorsal protuberance. Dorsum dull brownish-black, ventral plates brown.

Third stage (Pl. XVII, *E*).—Long slender larva. Average length of five almost mature specimens, 31 mm.; width, 5 mm. Caudal appendages long (2 mm.), rather slender, curving slightly backward up to short, acute dorsal protuberance located in middle and straight beyond these. Color dull to shining black above, very dark brown below. Ventral plates rather thickly clothed with short hairs. Anterior ventral plates 2 to 7, inclusive, oval in form with slight dilations irregularly occurring in middle of anterior margins. Anterior ventral plates also without median keel as appears occasionally in *obsoletum*. Posterior median plates in well fed larvæ without broad line of separation between the two plates, apparently joined, especially on 6th and 7th abdominal segments. Inner angles of all these plates square, outer rounded, with outer margins containing broad deep notch in middle. Posterior angles of anal segment short, obtuse, bearing spine at apex. Posterior angles of tergite of penultimate segment also obtuse in form, almost truncate at apices.

LARVAL RECORDS.

Some feeding records were secured with larvæ of this species by Mr. Caffrey in August, 1913, at Koehler, N. Mex. At that time, *H. oliviae* larvæ which were offered were almost full-grown and in most cases only a small number were required before maturity. Two to three caterpillars were consumed in the first larval stage, 2 in the second, and 4 to 6 in the third, or a total of about 10 to 12. The beetle larvæ were transferred from small containers for pupation upon approaching maturity and the feeding record closed, otherwise it is probable that slightly more would have been destroyed. These beetle larvæ were active and fed from about August 13 to August 26.

The average time required to pass the first larval stage was 6 days; for the second 4.5, and for the third to date ceased feeding, 8. Additional to this, from 3 to 5 days are passed in the prepupal stage, thus totaling 22 to 25 days in the larval stages to period of pupation. The larva in the last few days of its activity makes an oblong-oval cell in the earth for pupation, as is the habit with other species of the genus.

PUPA.

Two rather undersized specimens reared at Koehler, N. Mex., measured 17 and 15 mm. in length and 7.5 and 7 mm. in width, respectively. These specimens were somewhat broken in shipment to Melrose Highlands, Mass. The first five abdominal segments are clothed with short hairs dorsally while the remainder of the segments are smooth. General appearance same as other species of the genus.

Several of the larvæ reared in 1914 lived to pupate and adults were secured. Pupation took place in a cavity in the earth which was usually formed at the bottom of a glass jar where observations could be made on the transformations. The specimens studied pupated in July and August. Eleven to fourteen days were passed in this stage.

July 11, one pupa was noted in cavity, light yellow in color with dark brown eyes. July 25, 10 a. m., the beetle was fully formed, body, wings, and femora still white; eyes, tibiæ, and tarsi black; 1.30 p. m., the immature beetle all black except central portion of body; 6.30 p. m., beetle all black and fully formed but occupying pupal cavity.

July 26, a female emerged from the cavity. Other young beetles emerged in breeding experiments at this time instead of remaining in the same cavity for hibernation. Some of the species reared at Melrose Highlands, Mass., namely, *calidum*, have this habit to some extent.

CALOSOMA TRISTOIDES Fall.

ORIGINAL DESCRIPTION.

This name is proposed for a form occurring in our extreme southwestern region, which is closely related to but quite surely distinct from *triste* of the west central states. As compared with Kansas specimens of *triste*, in my collection *tristoides* differs in the much finer punctures of the elytral series, these becoming very minute posteriorly, and in the usually well developed greenish lustre of the elytral margins. The sides and basal impressions of the prothorax also show more or less of the metallic lustre in many specimens, but in some it is barely perceptible. The coarser serial punctures of intervals 4, 8, 12 are green as in *triste*, but in the latter species the side margins of the body are scarcely at all so. In the type series of three examples of *triste* in the LeConte collection the sides of the prothorax are evenly rounded and the elytra are parallel in both sexes. In *tristoides* the prothorax exhibits considerable inconstancy in both relative and actual dimensions, the width varying from 1.53 to 1.72 times the length, the sides either evenly rounded or evidently straighter posteriorly; the basal sinuations are also variable in depth. The elytra are quite uniformly parallel in the male and a little wider posteriorly in the female. It is, however, very probable that a good series of *triste*, or for that matter of any other species of Calosoma, would show similar variability. In length *tristoides* ranges from 22 to 24 mm., width 9.4–10.2 mm. The length given for *triste* in LeConte's table is 18 mm.

Tristoides is based on a good series taken by Mr. Ricksecker at or near San Diego, Cal. A single specimen from an unknown source and simply labeled "Cal." has stood for years in my collection as *triste*. There is a single example from "Cal." in the LeConte collection placed near but not in line with his specimens of *triste* and bearing a "?" label.

This species was described by Mr. H. C. Fall in 1910[1] from specimens taken at or near San Diego, Cal., by Mr. Ricksecker. The writers have examined two female specimens collected by Mr. W. M. Mann, at Pachuca, Hidalgo, Mexico. Mr. H. W. Wenzel, of Philadelphia, has kindly furnished a cotype of this species for examination and study.

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[1] Fall, H. C. Miscellaneous notes and descriptions of North American Coleoptera. *In* Trans. Amer. Ent. Soc., v. 36, p. 89–197 (p. 92), 1910.

CALOSOMA CALIDUM (Fab.).

(Syn.: *Calosoma lepidum* Lec.)

ORIGINAL DESCRIPTION.

[Translation.]

Carabus, wingless, black, elytra crenate-striate and with hollowed out golden punctures in triple row.

Habitat in America.

Related to *Carabus hortensis*, but with elytra by no means as smooth, interstices between the golden punctured striæ very elevated, crenate. Antennæ reddish at the apex.

EARLY RECORDS OF THE SPECIES.

This species was first described by Fabricius in 1775 and was given a place in his other writings until 1801. During the latter year the genus Carabus was subdivided into Carabus and Calosoma and this species was included in the latter group. Latreille, Say, Dejean, and Kirby gave descriptions of the species and notes as to its habitat. The latter in 1837 wrote that "it is very common in all parts of North America."

LeConte, in 1845, described a new species as *Calosoma lepidum* from the Territory of Missouri, but later writers and collectors seemed to have ignored it. There is no record of the species in any of the public collections of the United States save the single type specimen in the Museum of Comparative Zoology, Cambridge, Mass. An examination shows that this specimen should be referred to *C. calidum*, therefore *lepidum* is regarded as a synonym.

Glover, Fitch, Walsh, and Riley have all published brief notes on this species. F. G. Schaupp in 1882 made a biological study of the species and described the larva. In 1896 and 1897 the senior writer made further studies into the life history of the species and described the larval stages.

Various other writers, namely, Comstock, Fletcher, Lintner, Packard, Forbes, Bruner, and others have published many interesting notes on the feeding habits of the beetles and their larvæ, together with their occurrence in different parts of the continent.

DISTRIBUTION.

This species is found in Colorado, Connecticut, Delaware, District of Columbia, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Pennsylvania, South Dakota, Tennessee, Vermont, Virginia, and Wisconsin. It has also been reported from Alberta, Nova Scotia, Ontario, and Quebec, Canada.

SHIPMENTS.

November 6, 1911, two males and one female were removed from hibernation cages, packed with damp sphagnum moss in perforated tin boxes, which were inclosed in a tube and mailed to Mr. E. M. Ehrhorn, Honolulu, Hawaii. On December 1 he wrote that the beetles reached him in fine condition. This was the first experiment, to the writer's knowledge, in shipping Calosoma beetles long distances while dormant. It was successful, however, in this small attempt, and could be tried on a large scale when many specimens are to be transferred from one country to another.

A further attempt was made in 1912 to forward adults of this species to Mr. Ehrhorn, and small shipments were made by mail May 22, June 6, and June 17. A total of 16 males and 23 females, all alive, were sent, and 21 of the 39 specimens reached Honolulu alive. They were packed singly in pill boxes with damp sphagnum moss, but the moss had dried out in many cases on arrival, according to information received. The beetles were liberated in the foothills to prey upon cutworms which were very numerous in the islands. The genera Calosoma and Carabus are unrepresented there, which partly explains the annual abundance of cutworms. *C. calidum* in both the larval and adult stages seems perfectly adapted to prey upon cutworms and favorable results are bound to ensue if the species can be successfully established.

HABITS OF ADULTS.

May 31, 1911, a lively male was placed upon a section of a white oak tree set up in an outdoor cage, in order to make some observations on its climbing habits. (Pl. III.) It climbed very slowly and awkwardly, each time making more than one attempt before firmly gripping the bark and moving upward. The specimen on trial did not appear at all sure-footed, falling often and as soon as on level ground would move very rapidly.

Mr. Mosher says that he has repeatedly seen adults of this species under burlaps feeding upon caterpillars of *Porthetria dispar*, but has not seen them higher on trees than where burlaps are usually placed. They are sometimes collected on tree trunks at sugar when "sugaring" for moths.

REPRODUCTION.

The highest number of eggs deposited by one female in a single season was 74, but another deposited 61. Close records were kept of a few pairs of beetles in the years 1909, 1910, and 1911, with special reference to their capacity for reproduction. Only a part of the females reproduced each year they were in captivity, and the number of eggs that were deposited varied from 16 to 61 per female. One pair of beetles was observed in copulation May 20, 27, and 29, and June 2, 21, and 22, but only 16 eggs were deposited. It is probable that this species resembles *sycophanta* in that some of the females live an entire season without laying eggs.

LONGEVITY.

Most of the specimens of *Calosoma calidum* collected in New England and confined in jars have not lived longer than one year. One female, however, which was collected August 20, 1909, lived until June 5, 1911. One male was placed in the jar with the female shortly after she was collected, but died during the following fall or winter. Another male, added in the spring of 1910 and collected the same year, lived until after the female died in 1911. No eggs were deposited by the female in 1909 or 1910, but 22 fertile eggs were deposited in the spring of 1911. As the female was collected late in the summer (Aug. 20) it is both possible and probable that it was a recently issued adult, as it is shown below under "Food consumed by adults" that the beetles often come to the surface of the earth and wander about in search of food after emerging from the pupa. The male that was added in the spring of 1910 was a pupa in the summer of 1909 or earlier; therefore it also lived about two years or more.

The data at hand on this species will not permit the statement that the adults live longer than two years. There is a possibility, however, that they live three years, or as long as *sycophanta*, *inquisitor*, *wilcoxi*, and others.

FOOD CONSUMED BY ADULTS.

In Table 23 are given the best records secured on the food consumed by this species.

Table 23.—*Feeding records of 3 pairs of Calosoma calidum, 1909, 1910, and 1911.*

Pair No.	Year.	Feeding record started.	Ceased feeding.	*Noctua clandestina* (sixth stage).	*Malacosoma americana* (fifth and sixth stages).	*Porthetria dispar* (fifth and sixth stages).	Total.
1797	1909	June 13	July 1[1]	....	130	69	199
2879	1910	May 4	July 29[2]	13	183	[3] 121	[3] 317
5069	1911	June 6	July 26[1]	....	57	[3] 104	[3] 161

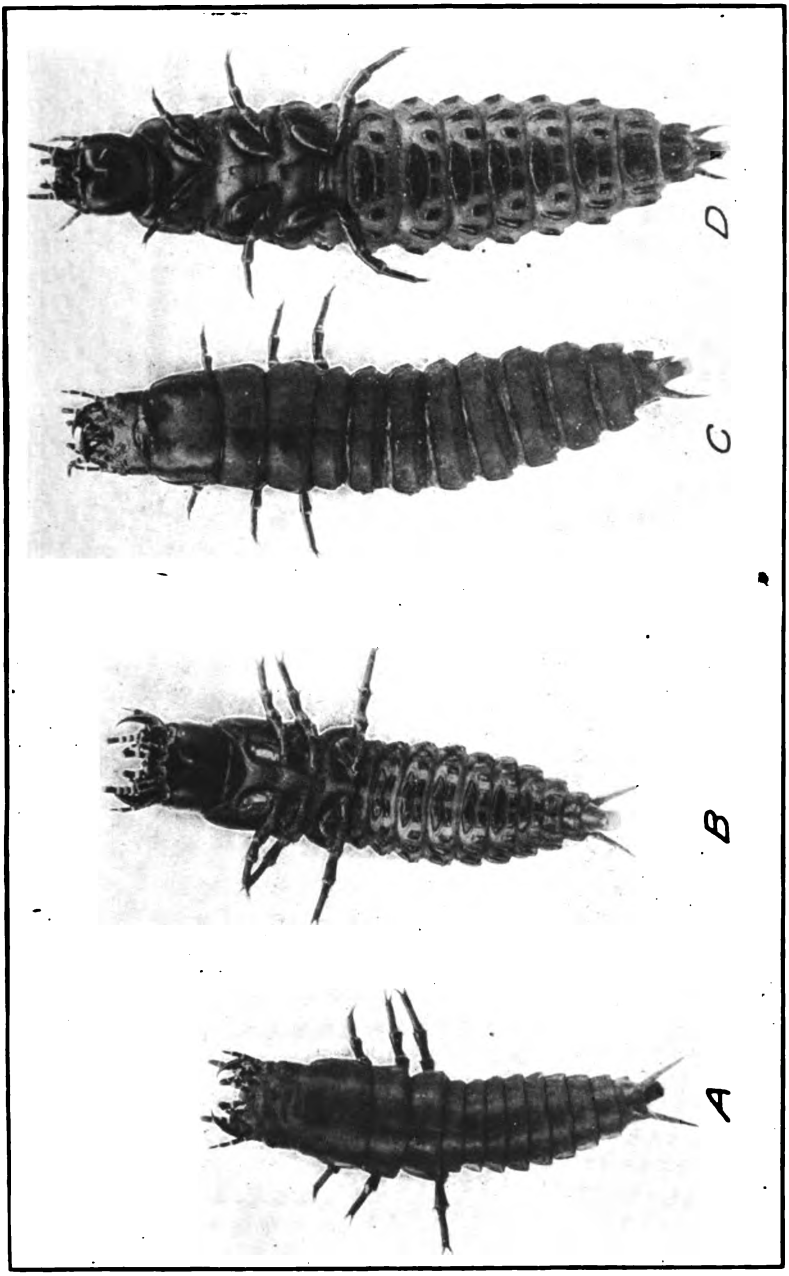
[1] Female died, record discontinued.
[2] Pair entered hibernation.
[3] Besides one pupa.

Each of the pairs cited in Table 23 reproduced; the first female deposited 59 eggs, the second 16, and the third 24. The record of the 1909 pair is incomplete as the male was not collected until June 13, on which date the record was started, and the female died July 1, thereby shortening the active feeding period by about two months. The average number of large-sized caterpillars devoured by each pair was 226. The period of emergence from hibernation for this species is from April 15 to May 15, and the period of entering hibernation August 1 to 15, leaving an active period extending over approximately three months.

One female reared from the egg in 1909 came to the surface and devoured two sixth-stage caterpillars of *Porthetria dispar* and 70 third and fourth stage caterpillars of *Hyphantria cunea* before reentering the ground for hibernation on September 11. Two males and one female, reared from eggs in 1910, came to the surface of the earth in from one to nine days after transformation from the pupæ. The males ate 21 and 28 sixth-stage caterpillars of *P. dispar*, respectively, before reentering hibernation August 4. The female ate three caterpillars and died.

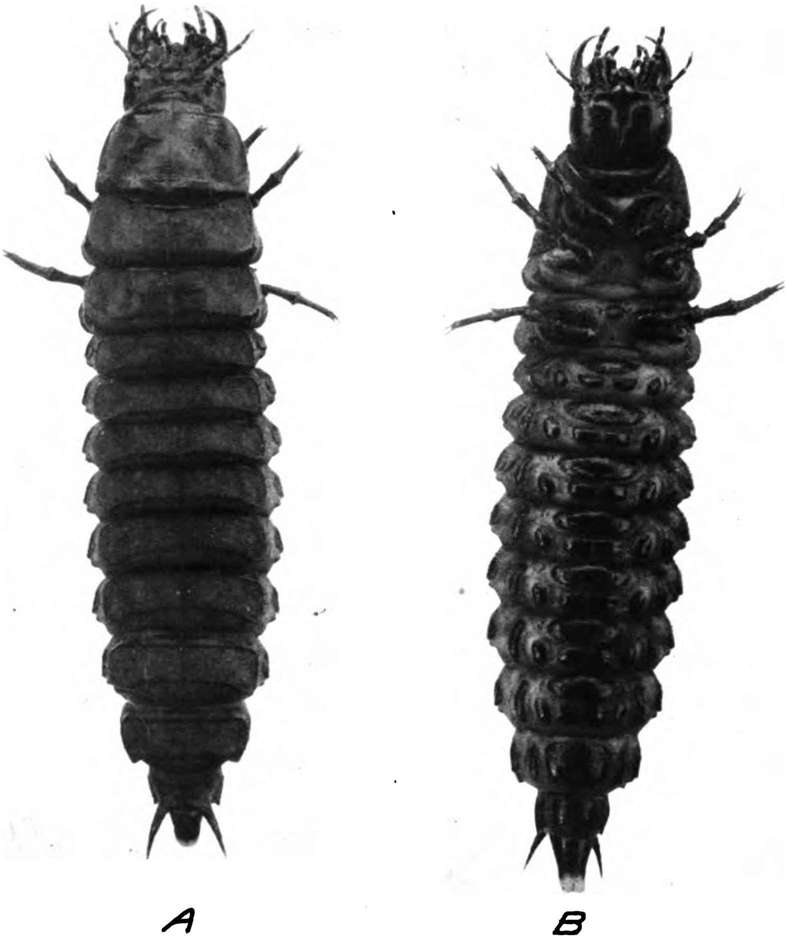
All the specimens of this species reared in jars or cages during 1909, 1910, and 1911 came to the surface in search of food in a few days after transformation from the pupæ. Young adults of *Calosoma calidum* are so voracious that sometimes after coming on the surface they attack one another, if caterpillars are not available.

The habit of feeding during the first fall after entering the adult stage is rather uncommon with other species of Calosoma that have been studied in detail by the writers.



CALOSOMA CALIDUM.

A.—First-stage larva, dorsal view, ×6. *B*.—Same, ventral view, ×6. *C*.—Second-stage larva, dorsal view, ×5. *D*. Same, ventral view, ×5. (Original.)



CALOSOMA CALIDUM.

A.—Third-stage larva, dorsal view, ×4. *B.*—Same, ventral view, ×4. (Original.)

HIBERNATION.

One pair of beetles entered hibernation August 30 and emerged May 17 and 26, 1910, and the average date of entering for 10 adults in 1910 was August 1. Only one pair of these beetles lived, and they emerged May 15, 1911. During normal seasons in Massachusetts this species enters hibernation during the first half of August and emerges between April 15 and May 15.

The average depth in the ground to which these beetles go to hibernate is about 2 inches.

THE EGG.

The egg is white. Measurements of 12 fresh eggs in 1910 gave an average length of 5.8 mm. and a width of 2.5 mm. The adults of *C. calidum* are much smaller than *scrutator* or *sycophanta*, but the eggs run somewhat larger than those of either species. They have the same general form (elliptical) as those of the species just mentioned and taper slightly toward one end.

The average number of days required to hatch 59 eggs deposited by one female between June 15 and June 28, 1909, was 4½. The temperature at that time was very favorable for the acceleration of hatching, the maximum ranging between 80° and 90° F. One hundred and ninety-nine fertile eggs deposited by several females between May 22 and August 2 required an average of nine days to hatch. Most of the deposition took place during the month of June, and nine days is about the normal time spent in the egg stage by this species.

DESCRIPTION OF LARVA.[1]

First stage (Pl. XVIII, *A*, *B*).—Length, 8 mm.; width, 2 mm. at third thoracic segment. Form ellipsoidal, tapering more gradually toward the last segment than in the corresponding stage of *C. frigidum*. General color of the body and mouth parts dull black, not shining. Head large, as long as wide, dorsal surface flattened; palpi prominent, longer than antennæ. Posterior margin of the head somewhat emarginate at the center. First thoracic segment as long as the two following, slightly wider than the head and edges produced laterally. All the body segments except the last are truncate behind, and bear a prominent impressed dorsal line. Caudal appendages present, simple, and provided with numerous spines.

Ventral portion of the body nearly pure white, but it is profusely covered with small black chitinous plates. Spiracles nine, black, circular, and arranged just below the lateral edges of the dorsal plates. Anal proleg moderately stout. After feeding for a week the larvæ molted.

Second stage (Pl. XVIII, *C*, *D*).—Soon after molting the larvæ become black and measure 18 mm. in length. Body somewhat stouter than in preceding stage. Head longer than wide, emarginate behind. Prothorax wider than the head. Dorsal line quite prominent. Abdominal segments truncate and slightly produced laterally. The second molt occurred at the end of a week.

Third stage (Pl. XIX, *A*, *B*).—The following description was not made until the larva was almost ready to pupate. Length, 30 mm. Color, dull black. Head of medium size, flattened, truncate behind. Clypeus slightly broader in front than in *C. frigidum*. Strongly bilobed. Suture between clypeus and epicranium subobsolete. Mandibles stout, the large tooth near the base being deeply cleft on the inner margin. Prothorax longer than the head, the hind angles slightly curved. Meso- and meta-thorax smaller, but similar in shape, each thoracic segment bearing four pairs of hairs on the dorsal plate. The abdominal plates one to seven of the same form and bearing a moderate carina near the posterior edge of the segment. Eighth segment a little larger, slightly wider, and also bearing a carina, lateral edges of each abdominal segment bearing three short hairs. The last segment small, posterior angles produced backward, but hind edge of segment truncate; caudal appendages long, blunt, spiny, slightly depressed, and bearing on the upper surface a hump-like protuberance provided with a few spines. The spiracles are nine in number, and are arranged the same as in *C. frigidum;* the color, however, is black. Legs small and spiny, tarsi bearing two claws. The anal proleg is stout and covered with numerous short hairs. The under surface is of a purer white than in *C. frigidum,* but bears similar markings. The latter resemble those of the preceding species in form and arrangement, but are slightly darker in color. The spots composing the first lateral row are more elongated and all the ventral spots are somewhat larger than in the preceding species. The time spent in this stage is about one month, of which about three weeks are passed in feeding. When full grown the larva burrows into the ground to a depth of several inches, and after preparing a cavity throws off its skin and goes into the pupal stage.

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[1] Burgess, A. F. Notes on certain Coleoptera known to attack the gypsy moth. *In* 44th Ann. Rpt. Mass. State Bd. Agr. f. 1896, p. 412-431 (p. 426-428), pl. 3-5, 1896.

LENGTH OF TIME REQUIRED TO COMPLETE LARVAL STAGE.

From several feeding records kept of larvæ that hatched between June 20 and 24, 1909, it was possible to secure information on the length of time required to complete the different larval stages. It was found at that time of year that an average of 3 days was required to pass the first stage, 5 days for the second, and 12 days for the third, or a total of about 20 days between hatching and cessation of feeding. No notes were secured with this series of larvæ as to the time when feeding ceased and pupation began, but observations on larvæ in 1911 showed that 6 days were spent in the prepupal stage.

Some data secured in 1912 show that from 3 to 5 days were required for larvæ to complete the first stage, 4 to 6 days for the second, and 12 to 17 days for the third. A fair average for these would be 4 days for the first stage, 5 for the second, and 15 for the third, or a total of 24 days for the active feeding period. These larvæ hatched May 20 to May 28—much earlier in the season than those referred to under 1909 when the weather was cooler, and this wholly or in part explains the longer time required to complete the growth in 1912.

FOOD CONSUMED BY LARVÆ.

The most natural food of these beetles and their larvæ is cutworms but it was not always convenient to collect these in sufficient numbers for the feeding experiments, so caterpillars of *Porthetria dispar* and *Malacosoma americana* were used. A series of individual records was kept in 1909 and 1910 with caterpillars of these species as a source of food supply. In 1911 a series was kept, feeding pupæ of *M. americana* only, after the cocoons had been removed.

TABLE 24.—*Food eaten by larvæ of Calosoma calidum, 1909–10.*

Date hatched.	Date ceased feeding.	*Malacosoma americana* caterpillars, fifth and sixth stages.	*Porthetria dispar* caterpillars, sixth stage.	Total.	Date hatched.	Date ceased feeding.	*Malacosoma americana* caterpillars, fifth and sixth stages.	*Porthetria dispar* caterpillars, sixth stage.	Total.
1909.					1910.				
June 20	July 8	[1] 10	13	23	May 29	June 22	9	1	10
23	12	4	13	17	June 2	24	10	5	15
23	12	3	16	19	2	22	9	0	9
24	13	1	21	22	7	30	7	4	11
24	16	3	20	23	7	28	7	3	10
24	17	1	13	14	7	28	13	5	18
					7	30	6	8	14

[1] Two of these caterpillars were in the third stage.

The average number of caterpillars eaten by each larva in 1909 was 20, and in 1910, 13. Sixth-stage caterpillars only were supplied in the latter series, while several fifth-stage caterpillars were offered in the former. Twenty large caterpillars (the same or similar to *Porthetria dispar*, or *Malacosoma americana*) is about a fair average for each larva to consume.

The larvæ in Table 24 were active and fed over an average period of 21 days after hatching, and then entered the ground for pupation. Larvæ of *C. scrutator* are active the same number of days but have a somewhat greater capacity for food.

Five larvæ were fed from hatching to maturity in 1911 on pupæ of *M. americana* from which the cocoons had been removed. From 6 to 10 pupæ were devoured by each larva, or an average of 9. Larvæ of this species did not attack and devour as many pupæ as caterpillars, and the same is true of other species of Calosoma.. When a Calosoma larva attacks and devours a pupa, it usually feeds until nothing remains but the empty case, but when a caterpillar is attacked part of the fluids and body contents are lost in the struggle of the caterpillar to free itself from the Calosoma.

HABITS OF LARVÆ.

May 29, 1911, an experiment was begun to test the climbing of these larvæ. (Pl. III.) Six newly hatched larvæ were placed inside the tin circle and caterpillars of *Malacosoma americana* were liberated upon the tree and on the ground. Later in the day two of the larvæ were noted feeding upon caterpillars at the base of the tree. May 30 the larvæ were again noted feeding upon caterpillars on the ground, on which date five were found buried in the earth. These first-stage larvæ remained in the circle until about June 4 before transforming to the second stage and were deprived of food some of the time until they were on the verge of starvation. Later on, July 17 and 21, other first-stage larvæ were added and kept under observation for a few days. They were placed upon the tree frequently, but each time fell to the ground almost immediately. Second-stage larvæ were tested but did not climb except on one occasion when one was seen crawling up and down the trunk about a foot from the ground. The others died of starvation and did not attempt to climb so far as could be observed, although they were under observation for several days. One third-stage larva was left in the experiment for a few days and it made no attempt to climb for food but remained on and in the earth.

In all cases starvation resulted unless food was placed on the ground. These facts show conclusively that this species is terrestrial in habit during the larval stages and the same is usually true of the adults.

PUPA.

Pupæ of this species averaged as follows: The females, 17.5 mm. long and 7.7 mm. wide; the males, 15.7 mm. long and 6.8 mm. wide.

Close observations were made upon a series of larvæ fed in jars in 1911 to determine the actual time required to pass the pupal stage. It was found that 1 male pupa matured in 11 days, while the females matured in 9 and 10. An average of 10 days was required for each, including both sexes in the series. The adults from the pupæ in question issued from July 4 to 10.

BIBLIOGRAPHY.

1775. Fabricius, J. C. Systema Entomologiæ, v. 1, 268 p.

Page 237. Contains the original description of the species *calidum* under the genus Carabus.

1787. Fabricius, J. C. Mantissa Insectorum, t. 1, 348 p.

Page 197. Part of same description as the original.

1792. Fabricius, J. C. Entomologia Systematica, t. 1, 538 p. Hafniæ.

Page 147, No. 99. Same description as the preceding reference with additional notes. Habitat of the species in the American Islands.

1795. Olivier, A. G. Entomologie ou Histoire Naturelle des Insectes, t. 3, No. 35 (Carabe), p. 1–116, 14 pl.

Page 30, No. 26. Description of species with comparative notes to *Carabus jardinier*.

1801. Fabricius, J. C. Systema Eleutheratorum, t. 1, 506 p. Kiel.

Page 211. Same description as the preceding, but changing the name of the species to *Calosoma calidum*.

1804. Latreille, P. A. Histoire Naturelle Générale et Particulière des Crustacés et des Insectes, t. 8, 411 p.

Page 298. Short description and a note on habitat. "Il est de l'Amerique meridionale."

1823. Say, Thomas. Descriptions of insects of the families of Carabici and Hydrocanthari of Latreille inhabiting North America. *In* Trans. Amer. Phil. Soc., n. s., v. 2, no. 1, p. 1–109.

Page 74. Contains fuller description than the preceding.

1826. DeJean, le Comte. Species Général des Coléoptères, t. 2, 501 p.

Page 197. Description with references.

1837. Kirby, W. Fauna Boreali-Americana, Pt. IV. Insects. 325+xxxix p., 8 pl.

Page 19. Good description of the species with a note that it is very common in all parts of North America.

1845–1847. LeConte, J. L. Descriptions of some new and interesting insects inhabiting the United States. *In* Boston Jour. Nat. Hist., v. 5, p. 203–209.

Page 208. Original description of *Calosoma lepidum*.

1862. Rathvon, S. S. Entomology. *In* Rpt. U. S. Comr. Patents f. 1861, p. 585–620, 90 fig.

Page 591. Species common in southern Pennsylvania. Both adult and larva are great enemies to lepidopterous larvæ.

1863. Fitch, A. Ninth Report on the Noxious and Other Insects of the State of New York, p. 249–250.

Includes good notes on the feeding habits of the larvæ, dwelling especially upon the manner in which they search for and devour their prey.

1866. Glover, T. Report of the entomologist. *In* Rpt. U. S. Comr. Agr. f. 1866, p. 27–45.

Page 39. Notes on the cannibalistic habits of the larvæ and food of both adults and larvæ.

1869. Glover, T. Food and habits of beetles. *In* Rpt. U. S. Comr. Agr. f. 1868, p. 78–117, 189 fig.

Page 79. Notes on the feeding of the larvæ upon the army worm near Washington, D. C., also their habits.

1869. Walsh, B. D., and Riley, C. V. [Note.] *In* Amer. Ent., v. 1, no. 12, p. 247.

Answer to inquiry of M. Treat on habits of larvæ.

1870. Riley, C. V. Enemies of the cankerworm. *In* Ann. Rpt. Noxious, Beneficial, and Other Insects, Missouri, p. 102–103.

Page 103. Recorded as an enemy of cankerworms.

1870. Riley, C. V. [Note.] *In* Amer. Ent., v. 2, no. 11, p. 340.

Specimen determined from Rose Hill, Mo.

1873. Riley, C. V. Economic entomology. *In* Trans. Kans. State Bd. Agr., f. 1872, p. 292–325, 19 fig.

Page 308, fig. 9. Record of the adults preying upon *Anisopteryx vernata*.

1875. Glover, T. Report of the entomologist and curator of the Museum. *In* Rpt. U. S. Comr. Agr. f. 1874, p. 122–146.

Page 123. Species recorded as feeding upon Colorado potato beetle.

1877. Popenoe, E. A. A list of Kansas Coleoptera. *In* Trans. Kansas Acad. Sci., f. 1876, v. 5, p. 21–40 (p. 22).

1878. Riley, C. V. Ground beetles. *In* 1st Rpt. U. S. Ent. Com. f. 1877, p. 313–314, fig. 45–47.

Species recorded as feeding on Rocky Mountain locust.

1879. Williams, J. Beneficial insects. *In* 9th Rpt. Ent. Soc. Ontario f. 1878, p. 36–46, fig. 15–35.

Page 40. Species recorded as feeding on Colorado potato beetle, cankerworms, and cutworms, both in the adult and larval stages.

1880. Bowles, G. J. Canadian cutworms. *In* Ann. Rpt. Ent. Soc. Ontario f. 1879, p. 37–46, fig. 2–6.

Page 45. Recorded as feeding on cutworms.

1880. Comstock, J. H. Report of the entomologist. *In* Rpt. U. S. Comr. Agr. f. 1879, p. 185–347, 16 pl.

Pages 191, 256, and 292. Noted preying on army worm. Reported feeding on *Hibernia tillaria* and that its habits are similar to those of *C. scrutator* Fab.

1880. Fletcher, James. Entomology for beginners. *In* Canad. Ent., v. 12, no. 1, p. 32–35, fig. 4–5.

Page 34. Species feeds on adult June beetles and cutworms.

1882. Lintner, J. A. First Annual Report on the Injurious and Other Insects of the State of New York. 381 p., 84 fig.

Page 128. The species was found in great numbers in a field infested with the vagabond crambus (*Crambus vulgivagellus*), and probably feeds on them.

1882. Schaupp, F. G. Biological notes on, and description of the larva of *Calosoma calidum* Fab. *In* Bul. Brooklyn Ent. Soc., v. 5, p. 33–34.

1883. Riley, C. V. Cankerworms. *In* 3d Rpt. U. S. Ent. Com., p. 157–197, 7 fig.

Page 177. Preys on the spring cankerworms; climbs trees. Many were found around the tin bands on trees in the spring.

1883. Forbes, S. A. The food relations of the Carabidæ and Coccinellidæ. *In* Ill. State Lab. Nat. His. Bul. 6, p. 33–64.

Page 38. Stomachs of nine specimens examined and contents found to be composed of animal matter, chiefly fluid.

1889. Packard, A. S. Notes on the epipharynx and the epipharyngeal organs of taste in mandibulate insects. *In* Psyche, v. 5, p. 222–228 (p. 228).

1890. Bruner, L. Insects Injurious to Young Trees on Tree Claims. Univ. Nebr. Bul. 14 (Bul. Agr. Expt. Sta. Nebr., v. 3, art 2), p. 83–149, 98 fig.

Page 149. Mention made of the species feeding upon caterpillars of *Clisiocampa americana*.

1893. Lintner, J. A. Eighth Report on the Injurious and Other Insects of the State of New York f. 1891. *In* 45th Rpt. N. Y. State Mus., p. 105–320, 51 fig.

Page 237. The larva known as the "cut worm lion" is very destructive to cutworms.

1894. Leng, C. W., and Beutenmuller, W. Preliminary hand-book of the Coleoptera of North Eastern America. *In* Jour. N. Y. Ent. Soc., v. 2, no. 3, p. 133–141, pl. 3.

Page 141. Classification and brief description.

1895. Fernald, C. H. Entomologist's report. *In* 4th Rpt. Mass. State Bd. Agr. on the work of extermination of the gipsy moth, p. 27–29.

Page 28. Reported as feeding upon the gipsy moth.

1895. Comstock, J. H., and Anna B. Manual of the Study of Insects. 701 p., 797 fig. Ithaca.

Page 519. Beetle called the "fiery hunter," known to climb trees in search of food.

1896. Forbush, E. H., and Fernald, C. H. The Gypsy Moth. Mass. State Bd. Agr., 495+c p., 66 pl., 34 fig.

Pages 381, 383. Brief notes on the adults feeding upon *P. dispar* caterpillars.

1897. Burgess, A. F. Notes on certain Coleoptera known to attack the gypsy moth. *In* 44th Ann. Rpt. Mass. State Bd. Agr. f. 1896, p. 412–431, pl. 3–5.

Pages 426–430. Contains description of the larvæ in all stages and notes on habits of adults and larvæ.

1898. Burgess, A. F. Notes on predaceous beetles, 1897. *In* 45th Ann. Rpt. Mass. State Bd. Agr. f. 1897, p. 402–411.

Page 409. Notes on rearing the species.

1899. Fletcher, James. Report of the entomologist and botanist. *In* Canada Expt. Farms Rpts. f. 1898, p. 167–219, 24 fig.

Page 190, fig. 14. Notes on the variations of color in the spots of the elytra; also refers to the larva of the "cutworm lion."

1910. Blatchley, W. S. The Coleoptera or Beetles of Indiana. 1386 p., 590 fig.
Brief description with notes on occurrence and habits.

CALOSOMA MORRISONII Horn.

ORIGINAL DESCRIPTION.

Black, moderately shining. Head moderately closely punctate, rugulose at the sides, mandibles transversely wrinkled. Thorax twice as wide as long, base and apex nearly equal, sides strongly arcuate in front, oblique behind, hind angles very obtuse, lateral margin narrow in front, more widely reflexed posteriorly, the basal impressions moderately deep, apex feebly, base more distinctly emarginate, median line distinct, surface moderately closely punctate and more rugulose at the sides and along the base. Elytra oval, widest behind the middle in both sexes, humeri distinct, surface rather shining, with about fifteen rows of rather fine not closely placed punctures, the intervals with a single row of finer and more distinct punctures, the fourth, eighth, twelfth, and submarginal intervals with a series of moderately distant larger golden punctures. Prothorax beneath sparsely punctate, metathorax at sides more coarsely, abdomen sparsely punctate at the sides. Length .72-.82 inch, 18-20 mm.

The male has three joints of the anterior tarsi spongy pubescent beneath. This species from the evident golden elytral spots must be associated with *calidum* and *tepidum*, than either of which it has much smoother elytral sculpture although resembling them in general form. It might be mistaken for a smooth variety of *obsoletum*, but the elytra are more dilated, their sculpture smoother, and without the imbricated appearance. The base of the thorax is distinctly bisinuate in *obsoletum* and simply emarginate in the present species as well as in those with which it is associated.

Collected by Mr. H. K. Morrison in Colorado. With it I associate his name as an evidence of my appreciation of his industry and success in adding to a knowledge of our fauna.

EARLY RECORDS AND DISTRIBUTION OF THE SPECIES.

This species was described by Horn in 1885[1] from specimens that were collected in Colorado by H. K. Morrison. Specimens that are deposited in a few museum collections in the United States bear locality labels from Colorado and southern California. It appears not to be particularly common in any State, although the most have been reported from Colorado.

CALOSOMA TEPIDUM Lec.

(Syn.: *C. irregulare* Walk.)

ORIGINAL DESCRIPTION.

Black, with head and thorax closely wrinkled, thorax very broad, narrowed at the posterior end, sides much rounded, margin somewhat reflexed, with base lightly bisinuate, marked on both sides, elytra extended slightly posteriorly, finely striate, with spaces between the striæ much corrugated, almost broken into granules, and with bronze-colored pits in triple row.

Length .75.

Shorter than *C. calidum* and differs in having elytra quite rough; it seems similar to *Callisthenes*, and shows its likeness in antennæ, 5th and 6th joints, glabrous margins, pubescent at the base, with the glabrous part poorly defined, and 7th to 11th joints equally pubescent, described in this species.

Oregon. I have seen another specimen in the Collection of the Exploring Expedition.

This species was described by Le Conte in 1851. Mr. J. K. Lord published in 1866 the description of a new species, *Calosoma irregulare*, described by Walker, the habitat of which was not given and compared it with *C. calidum*, *C. frigidum*, and the Siberian *C. denticolle*. In 1871 Horn reduced this species to a synonym of *C. tepidum*. There are no records at hand to show that *C. irregulare* is represented in any of the public museums and experiment-station collections of the United States, consequently the writers have not been able to study specimens.

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[1] Horn, G. H. Contributions to the Coleopterology of the United States. *In* Trans. Amer. Ent. Soc., v. 12, p. 128-162, pl. 4-5, 1885.

C. tepidum has been reported from the following States: Arizona, California, Colorado, "Dakota," Idaho, Montana, Nebraska, Nevada, Oregon, Utah, Washington, and Wyoming. British Columbia, Alberta, and Vancouver Island are points in Canada from which specimens have been collected.

BIBLIOGRAPHY.

1852. LeConte, J. L. Description of new species of Coleoptera from California. *In* Ann. Lyc. Nat. Hist. N. Y. f. 1851, v. 5, p. 125–216.

Page 199. Original description of *C. tepidum* in comparison to *Calosoma calidum*. Habitat, Oregon.

1866. Lord, J. K. The Naturalist in Vancouver Island and British Columbia, v. 2, 375 p.

Page 312. Description of *Calosoma irregulare* by Walker without locality for type specimen. Comparisons are made of this species with *calidum* and *frigidum* and mention made of its alliance to the Siberian *C. denticolle*.

1870–1871. Horn, G. H. Contributions to the Coleopterology of the United States. *In* Trans. Amer. Ent. Soc., v. 3, p. 69–142, pl. 1.

Comparisons of specimens collected in Oregon and California, also the following notes under *C. tepidum:* "This species has been redescribed as *C. irregulare* by Walker, Naturalist in British Columbia, Lord, Vol. II, p. 312."

1890. Harrington, W. H. On the list of Coleoptera published by the Geological Survey of Canada, 1842–1888. *In* Canad. Ent., v. 22, no. 7, p. 135–140.

Page 139. Catalogue of the Coleoptera determined for the Geological Survey of Canada by Dr. J. L. LeConte notes the collection of *C. tepidum* in British Columbia.

CALOSOMA AUROPUNCTATUM (Payk.).

ORIGINAL DESCRIPTION.

[Translation.]

Black, smooth, with thorax emarginate posteriorly, elytra finely punctate-striate, and punctures of uneven depth a little larger in triple row.

Description of male.

Head entirely black; antennæ becoming brown at the apex.

Thorax black, smooth, marginate, obovate, almost twice broader than long, sides rounded; truncate anteriorly, somewhat emarginate posteriorly.

Elytra black, scarcely broader than the thorax, very finely punctate-striate: punctures a little larger depressed in triple row.

Sternum black.

Abdomen black.

Feet black. Tibiæ curved.

In size and length it almost exceeds the preceding, (*Carabus reticulatus*) but it does not equal it in breadth.

Female similar to male, but somewhat greenish above in color, coppery punctures in triple row, abdomen scarcely broader, and anterior tibiæ shorter. Habitat rare in southern Switzerland. It differs from *Carabus inquisitor* in color, in emarginate thorax and smoother elytra, from *Car. reticulatus* in color, body more elongated and elytra not at all reticulated.

Synon. Herbst. *Carabus auropunctatus.*, Fab. Mant. Ins. p. 197. No. 35, *Car. indagator?* is related to this, but this one is wingless as only a hasty description was seen by the author.

EARLY RECORDS OF THE SPECIES.

This species was first described by Paykull in 1790 and its habitat given as southern Switzerland. Dejean, in 1826, put it in the genus Calosoma as it had previously been identified as Carabus. Gebler, in 1833, writes of the great similarity of this species to *C. denticolle* Gebl. Houlbert and Monnot, in 1905, made a study of *C. auropunctatum* and came to the conclusion that *C. sericeum* of Fabricius and *C. indagator* of Gyllenhal were synonyms of it.

IMPORTATIONS.

The only importation of this species was received at the gipsy moth parasite laboratory June 1, 1909, from Miss Ruhl. The shipment contained nine males and nine females alive and three males and one female dead. Requests were made for Miss Ruhl to collect more and forward them but it seemed impossible for her corps of collectors to find them owing to the scarcity of the species in central and southern Europe.

HABITS OF ADULTS.

June 29, 1911, one female was tested to ascertain if adults of this species naturally climb trees in search of prey. (Pl. III.) The beetle when left inside the circle crawled about and up to the base of the tree but did not attempt to climb. When put upon the bark, head upward, it would turn around very quickly and climb downward to the ground. When placed upon the tree near the top, the beetle would lose its footing and fall. No climbing experiments were conducted with the larvæ.

This species is evidently terrestrial in habit.

FOOD CONSUMED BY ADULTS.

Feeding records were kept daily of a series of pairs of beetles received from Europe June 1, 1909, and these records were extended over two years, 1909 and 1910, as shown in Table 25.

Table 25.—*Feeding records of four pairs of Calosoma auropunctatum, 1909–1910.*

1909.

Pair No.	Feeding record started.	Ceased feeding.	Sixth-stage caterpillars.		Total.
			Malacosoma americana.	*Porthetria dispar.*	
2709	June 2	July 16	81	47	128
2710	2	19	85	48	133
2711	2	Aug. 16	95	67	162
2712	3	9	115	80	195
Average per pair					155

1910.

Pair No.	Female emerged and record started.	Ceased feeding	*Malacosoma americana*, fifth and sixth stages.	*Porthetria dispar*, sixth stage.	*Estigmene acraea*, sixth stage.	Total.
2709	May 26	Aug. 12	65	166	11	242
2710	23	12	84	[1] 156	11	253
2711	June 7	5	57	[2] 140	1	199
2712	May 24	July 30	53	125	3	181
Average per pair						219

[1] Besides two pupæ.

[2] Besides one pupa.

The male of pair No. 2712 died June 5, 1910, and the female alone consumed 151 of the 181 caterpillars totaled for that pair. Male No. 2709 died June 10 but another female was added to that jar, making two females. The males in the other two jars, together with all the females, lived to the end of the feeding season.

The average number of caterpillars consumed per pair in 1909 was much less than in 1910, which was probably partly due to the record being started a little late and because they were mostly first and second year beetles at that time. Female No. 2711 deposited 19 fertile eggs during the latter part of June, 1910, and more food was consumed in that year than in 1909. None of the other females in Table 25 reproduced during either year. The average number of caterpillars consumed per pair in 1910 is about the same as the average for *C. calidum*, which was 226.

REPRODUCTION.

Out of the lot of beetles imported in 1909 only three eggs from which larvæ hatched were deposited that year. Most of the beetles entered hibernation and lived to emerge during the spring of 1910, and during that year 152 fertile eggs were secured from the six females.

No copulation was observed among these beetles, but deposition of eggs was recorded almost continuously between May 26 and July 27. Only one female lived to issue in the spring of 1911 and there were no males left for mating.

LONGEVITY.

One female of the lot of beetles received from Europe June 1, 1909, lived until August 17, 1911. This female did not deposit eggs in any of the three years of her existence at the laboratory. It was a pupa in the late summer of 1908 or earlier and passed two winters and three summers at Melrose Highlands, Mass. Three females of the same lot died in hibernation during the winter of 1910–11. Notes secured on the length of life of this species show that the limit is three years or longer.

HIBERNATION.

The beetles received in 1909 fed freely for a time and entered hibernation between July 16 and August 20, the average date being July 31.

They emerged in outdoor cages in the spring of 1910 between May 3 and June 14, the average date being May 23. The cavities where they spent the winter were from ½ to 4 inches deep, or an average of 3½ inches.

A few of these old beetles again entered hibernation in the fall of 1910 with some young adults reared the same year, the average date of entrance being August 9. Only three females (one old and two young) were still alive in the spring of 1911, and these were unearthed June 7 and June 23. The beetles hibernated from 2 to 12 inches below the surface.

THE EGG.

The egg is white, slightly approaching a creamy shade.

Twelve eggs were measured in 1910 soon after deposition, giving an average length of 4.5 mm. and a width of 2.2 mm. The adults of *C. auropunctatum* Payk. run slightly larger than *C. calidum* Fab., but the eggs are much smaller. The eggs of the former species are elliptical in form and taper gradually toward one end.

The average number of days passed in the egg stage was 9, for 111 eggs observed in 1910. Fifteen days were required for hatching eggs deposited the latter part of May, when the weather was cool, but only three to six days were necessary late in June or early in July.

DESCRIPTION OF LARVA.

First stage.—Medium to small size, fusiform. Average length of 12 specimens, 9 mm.; width, 2.2 mm. Caudal appendages long, straight, bearing a few long spines. Color shining black above, ventral plates grayish-brown.

Second stage.—Somewhat stouter than first stage. Average length of nine specimens, 16.5 mm.; width, 3.5 mm. Caudal appendages stout at base, rather erect to dorsal protuberance, curved slightly upward and gradually tapering beyond protuberance. Protuberance short, erect, and located less than one-half the distance from base to tip. Color same as in first stage above, ventral plates dark brown.

Third stage.—Rather robust in form. Average length of four specimens, 22 mm.; width, 4.9 mm. Caudal appendages short, stout, and rather erect to dorsal protuberance, curved upward beyond this, acute at end. Protuberance more prominent than in second stage. Color of dorsum shining black with metallic luster, ventral plates dark brown. No reddish-brown patch at base of caudal appendages in second or third stages.

TIME REQUIRED TO COMPLETE LARVAL STAGES.

From 3 to 7 days are required for the first stage, or an average of 5; 3 to 5, or an average of 4, for the second; and 10 to 14, or an average of 11, for the third. The larvæ are active and feed about 19 or 20 days. Four days are passed in the prepupal stage.

TABLE 26.—*Food required to mature larvæ of Calosoma auropunctatum, 1910.*

No.	Date hatched.	*Malacosoma americana* eaten, sixth stage.	*Porthetria dispar* eaten, fourth to sixth stages.	Total.
2789-A	June 11	5	16	21
2789-B	[1] 11	5	40	45
2789-C	13	3	13	16
2789-H	14	6	46	52
2789-I	13	4	51	55
2789-J.	[1] 16	1	55	56

[1] Larvæ died when full grown.

The average number of large caterpillars required to complete the growth of 12 larvæ, 6 of which are given in Table 26, was 40. The larvæ of this species appear to be very voracious feeders, as from 16 to 56 large caterpillars were destroyed. The average for this species was twice that consumed by larvæ of *Calosoma calidum*.

Two larvæ of this lot pupated and issued as females in July, 1910. They came on the surface of the earth and ate 19 and 27 large caterpillars, respectively, before entering hibernation. These are the only adults that have been reared and indicates that this habit may be constant. This species resembles *C. calidum* in this respect.

PUPA.

Length of female, 19 mm.; width, 7.5 mm. Male, 18.7 mm. long, 7.2 mm. wide.

The larvæ under observation in 1910 ceased feeding June 27 to July 3, then entered the earth and constructed cavities. Pupation took place in 4 days and 12 to 13 days were passed in the pupal stage. The adults in a few days emerged from their cavities and came on the surface in search of food.

BIBLIOGRAPHY.

1790. Paykull, G. von. Monographia Caraborum Sveciae. 138 p.

Page 68, no. 41. Original description as *Carabus auropunctatus*.

1798. Paykull, G. von. Fauna Svecica, t. 1, 234 p.

Pages 129–130. Practically the same description as above, with note as to habitat in Southern Switzerland.

1826. DeJean, le Comte. Species Général des Coléoptères, t. 2, 501 p.

Page 203. Description of the species under the name of *Calosoma auropunctatum* and in comparison to *C. inquisitor*. The author gives it as a variety of *Calosoma sericeum* which he had previously thought to be a distinct species. *C. auropunctatum* is recorded as found in Austria, Germany, and France, but everywhere rare.

1830. Gebler, F. A. von. Bemerkungen über die Insekten Sibiriens, vorzuglich des Altai. Ledebours Reise, t. 2, p. 57.

1833. Gebler, F. A. von. Bulletin de la Société Imperiale des Naturalistes de Moscou, t. 6, p. 274.

The species is described as approximately like that of *Calosoma denticolle* Geb. from Siberia.

1877. Marseul, D. A. de. Mélanges. *In* L'Abeille, t. 15 (ser. 3, t. 3), ser. 2, no. 6, 1875, p. 22–24.

Record of a specimen pierced with a pin so as not to wound the ganglia and the beetle lived 18 months with the pin still in the body and fed voraciously during the time.

1887. Mayet, V. Description des larves des *Calosoma Maderae* F. et *Olivieri* Dej. *In* Ann. Soc. Ent. France, ser. 6, t. 7, p. clxxi–clxxiv.

The author states that *C. auropunctatus* is not found in Algeria.

1905–1907. Houlbert, E., et Monnot, E. Coléoptères. Carabides. *In* Trav. Sci. Univ. Rennes, Fauna Ent. Americaine, t. 1, pt. 2, p. 289–379, fig. 68–145.

Page 293. These authors claim that *C. sericeum* Fab. and *C. indagator* Gyll. are synonymous with *C. auropunctatum* Payk.

CALOSOMA CANCELLATUM Esch.

[Pl. XVII, *C.*]

(Syn.: *Calosoma aenescens* Lec.)

ORIGINAL DESCRIPTION.

[Translation.]

Thorax very short, rough, bronze, posterior angles produced, elytra greenish-bronze, obsoletely striate. Crossed with irregular short wrinkles with three series of elevated oblong punctures, tibiæ straight.

From California near San Francisco.

Length 9 lines. Head and prothorax colored very green, thickly punctate; prothorax very short, twice as broad as long, broader anteriorly than posteriorly; indented in front in the middle, straight posteriorly; the broad, blunt hind corners project out prominently, lateral margins broadly turned up, shield black. Elytra not much broader than prothorax, long, indistinctly striate, all the spaces between are uneven because of cross lines; broad intermediate spaces have larger grooves, whereby three rows of long chainlike granules are formed. On elytra all depressions colored light metallic green, all elevations very green. Ventral side of body has on the sides of prothorax and breast green glimmerings; all the rest as well as the legs are black. Middle tibiæ of female straight.

This species was described by Dr. Friedrich Eschscholtz in 1829, who recorded its habitat as California near San Francisco. It has later been taken in Arizona, California, Idaho, Indian Territory, Montana, Nevada, Oregon, Utah, and Washington. Dr. LeConte in 1854 described a new species (*Calosoma aenescens*) as occurring at Fort Vancouver. The writers have had the opportunity of studying the type which is deposited in the Museum of Comparative Zoology, Cambridge, Mass., and find it does not differ from *C. cancellatum* Esch., and it is, therefore, considered as a synonym of that species.

COLLECTIONS AND SHIPMENTS.

The late H. M. Russell, of this bureau, on June 9, 1910, forwarded a female of *C. cancellatum* Esch. from Compton, Cal., accompanied by a letter stating that he had found "the larva of the beetle feeding in a sugar-beet field on larvæ of *Peridroma saucia.* It disappeared about May 15 and was found as a beetle 3 inches below the surface of the ground June 6, 1910." This beetle died June 14 after its arrival at Melrose Highlands, Mass.

April 5 and 6, 1914, Mr. J. E. Graf, also of this bureau, collected at Compton, Cal., six males and two females of this species and forwarded same alive to Melrose Highlands, Mass. They were collected on low shrubbery, and Mr. Graf stated that they feed on coleopterous and lepidopterous larvæ.

FOOD OF ADULTS.

The adults received at Melrose Highlands, Mass., April 16, 1914, were offered larvæ of *N. clandestina,* of which one pair of beetles destroyed from 5 to 12 large larvæ per day. *M. americana* and *P. dispar* larvæ were consumed after May 15 to about July 8, when some of the adults died and others remained inactive in the earth.

REPRODUCTION AND HIBERNATION.

April 16, 1914, one pair of adults from California were enclosed in a rearing jar and fed regularly at intervals. From May 8 to June 18 eggs were noted in the earth, and a total of 11 larvæ hatched from eggs deposited by this female. In another jar containing five males and one female from the same source as above were found seven larvæ during the season. From these records it would appear that this species is not a prolific breeder.

No adults of this species lived to enter hibernation in the fall.

EGG.

Six eggs that had been preserved in alcohol averaged 3.7 mm. in length and 1.5 mm. in width. Color creamy-white, form elliptical, very slightly larger near the anterior end, tapering slightly toward the posterior.

The eggs were not found as soon as deposited, therefore close data on time required to pass the egg stage were not secured. It probably ranges from 6 to 12 days under Massachusetts conditions when the eggs are deposited in May, possibly less in California, the native habitat.

BRIEF DESCRIPTION OF LARVA.

First stage.—Small, rather slender larva. Average length of six newly hatched specimens that had been preserved in alcohol 8.1 mm., width 2.1 mm. Color dull black dorsally, ventral plates dark brown. Ventral and lateral plates lightly clothed with short brown hairs. Caudal appendages (1.4 mm. long) very slender.

Second stage.—Form similar to first stage. Average length of six specimens 17.7 mm., width 4.2 mm. Caudal appendages straight and rather blunt at apex. Color similar to first stage, but of somewhat lighter shade in the specimen studied.

Third stage (Pl. XVII, *G*).—Rather long, slender larva. Average length of six alcoholic specimens 25.5 mm., width 5.2 mm. Caudal appendages rather short (1.4 mm.), stout, slightly curved in center. Each appendage bearing stout dorsal protuberance on the middle. Appendages taper to a long point beyond dorsal protuberance. Color dull to shining black above, brown below. Ventral plates rather thickly set with hairs and regular in outline. Anterior ventral plates of abdominal segments 2 to 7

oval in form without regular marginal notches. Posterior median plates rectangular in form and outer ventral plates on third to seventh abdominal segments oval. Posterior angles of anal segment broad at base, acute at tip, projecting slightly upward.

LARVAL RECORDS.

Many larvæ were reared in individual jars during 1914 which were fed mostly on *N. clandestina* and *M. americana* larvæ. Those reared hatched May 8, 11, 22, and 24 and ceased feeding between June 9 and 15. The larvæ that hatched late in May matured in much shorter time—18 to 22 days, while those that hatched early in May required about one month. One and sometimes two large caterpillars were consumed by one beetle larva each day excepting during the molting periods, or a total of from 20 to 35 before maturity. Proportionately more would be destroyed if small caterpillars were offered.

Time spent in the larval stages for a few specimens averaged as follows: For first, 5 days; for second, 6 days, and for the third about 9 to 12 days to the date larvæ cease feeding for making cavity. About 4 days additional is passed in the cavity before pupation.

HABITS OF THE LARVÆ.

A first-stage larva put on the bark of a white oak post, after several tumbles reached the top (6 feet). Each time placed on with head upward, it would turn the opposite direction and descend, several times circling the post. Third-stage larvæ showed about the same inclination to reach the ground when placed upon the post. They were not able to ascend more than three feet before falling.

The slowness and awkwardness with which these larvæ handle themselves on trees indicated that their natural habits are similar to those of *C. calidum* Fab., that is, remaining always on or near the ground in search of food.

PUPA.

Two pupæ (1 male and 1 female) were preserved in alcohol from the rearings of 1914, the average measurements of which were 18.2 mm. in length and 7.3 mm. in width. June 20, 1 pupa was unearthed from a cavity at the bottom of a jar which was then about 5 days old, as determined from the colorations of the tarsi, eyes, and buccal parts. The color of the pupa as a whole grew darker daily until it died June 25. It is probable that about 10 to 12 days are required to pass the pupal stage for this species.

BIBLIOGRAPHY.

1829. Eschscholtz, J. F., Zoologischer Atlas enhaltend Abbildungen neuer Thierarten wahrend Kotzehue's, etc. Part I, Taf. XXV, p. 23.

Original description of *Calosoma cancellatum*.

1854. LeConte, J. L., Descriptions of some new Coleoptera from Oregon, collected by Dr. J. G. Cooper, of the North Pacific R. R. Expedition. Proc. Acad. Nat. Sci. Phila., T. 7, p. 16.

Description of *C. aenescens* from Fort Vancouver; comparison is made with *Calosoma tepidum* and *calidum*.

1857. LeConte, J. L., Report upon Insects Collected on the Survey (Coleoptera), p. 30.

Redescription of *Calosoma cancellatum* with a citing of the original description by Eschscholtz. Also a note that *C. aenescens* was collected in Sacramento, California.

CALOSOMA SUBAENEUM Chaud.

ORIGINAL DESCRIPTION.

[Translation.]

Length 17 mm. Like *discors* in form, but more narrow and much smoother. Head very slightly punctate, base and anterior margin smoother, impressions of face heavier. Thorax a little smaller, very finely and irregularly wrinkled above, more punctured toward sides and the base and especially towards the posterior angles which are less prolonged backward, more broadly rounded, sides of base very hollow near the angles, lateral margin reflexed, especially backward. Base of elytra almost as broad as thorax, broadening toward the middle and rounding somewhat to the end, one half longer than broad, humeral angles more square although rounded; anterior part of sides rectilinear, less convex above; striæ not impressed, composed of rows of small dots, moderately near each other, from each of which a very small transverse wrinkle covers the interstices; these dots and transverse wrinkles are more prominent at the sides and near the end and give the outer border a very wrinkled appearance. Shining black the upper side slightly tarnished; sides and base of thorax as well as all surface of the elytra, olive green bronze; on each are three rows of dots, slightly larger than those on the striæ, the first two are obsolete near the base. As it differs from all other species on account of the sculpture of the elytra and also by its narrowed form I have placed it provisionally at the end of the series.

One specimen reported from California by M. Lorquin.

This species was described as above by Baron De Chaudoir in 1869.[1] It occurs in California, Idaho, and Washington.

CALOSOMA MONILIATUM Lec.

(Syn.: *C. laqueatum* Lec.)

ORIGINAL DESCRIPTION.

Obscurely bronze, dark, head and thorax closely rugose and punctate, the thorax twice shorter than broad, somewhat narrowed posteriorly, sides moderately rounded, margin scarcely reflexed, base broadly emarginate, angles slightly produced, elytra one-half longer than broad, closely grooved, calli on both sides smooth, oblong, and pits arranged in triple row. Length .65. Oregon. Length 17 mm. Oregon. Montana.

Longer than rest, about the size of *Carabus serratus* Say.

This species was described by LeConte in 1852.[2]

In 1860 LeConte[3] described *Calosoma laqueatum* (Proc. Phila. Acad. Nat. Sci., vol. 12, p. 318), but later reduced it to a synonym of *moniliatum*. *C. moniliatum* occurs in Arizona, California, Idaho, Montana, Nebraska, Oregon, Washington, and in the Northwest Territory, Canada.

CALOSOMA CHINENSE Kirby.

[Pl. VII, fig. 10.]

ORIGINAL DESCRIPTION.

Dusky, blackish-coppery above, rough, elytra marked with golden punctures in triple row.

Length of body, 15 lines.

Habitat in China.

Body black underneath, blackish-coppery above, dark. Head marked with most minute confluent punctures. Thorax rough with close punctures or minute wrinkles, indistinctly canaled or furrowed dorsally, and deeply marked posteriorly on both sides. Elytra oblong-quadrate, roughened with very numerous, very minute granules, marked above with golden punctures in triple row. Epipleura very narrow.

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[1] Chaudoir. Descriptions de Cincindélètes et de Carabiques nouveaux. *In* Rev. et Mag. Zool. (ed. by Guéren-Méneville), ser. 2, t. 21, p. 22-28.

[2] LeConte, J. L. Description of new species of Coleoptera from California. *In* Ann. Lyc. Nat Hist. N. Y. f. 1851, v. 5, p. 125-216 (p. 200), 1852.

[3] LeConte, J. L. Notes on Coleoptera found at Fort Simpson, Mackenzie River, with remarks on Northern species. *In* Proc. Acad. Nat. Sci. Phila., v. 12, p. 315-321 (p. 318), 1860.

EARLY RECORDS OF THE SPECIES.

The original description of this species was published by Kirby in 1818,[1] its habitat being given as China. In 1831 Dejean[2] redescribed it as coming from the same country. The latter author compared it with *auropunctatum* Payk. in general markings and says it should be placed near *senegalense* Dej. The literature concerning this species is rather limited. The writers were able to secure only the two references above cited.

OCCURRENCE AND IMPORTATIONS.

Three hundred and fifty-three adults were collected and shipped to the gipsy moth parasite laboratory in two years. Along with the second shipment in 1910 were received specimens of *Carabus procerulus* Chaud., *C. tuberculatus* Fisch., and *Damaster blaptoides* Kollar. A specimen received January 5, 1910, was collected and mailed by Rev. H. Loomis, 53 Main Street, Yokohama, Japan, while the two large shipments were made from the Imperial Agricultural Experiment Station, Tokyo, by Prof. S. I. Kuwana. The beetles were packed singly in wooden boxes with damp sphagnum moss. About 40 of these small boxes were inclosed in a large wooden box. Arrangements were made with the steamship company whereby the boxes were kept in cold storage as far as Vancouver, British Columbia, and were then shipped by express, in larger boxes containing ice. The moss in many of the small boxes was still damp on arrival, and the beetles on the whole were in very fine condition, 83 per cent being alive on receipt. They were en route 18 days.

HABITS OF ADULTS.

The adults of this species are able to fly to some extent. They also climb trees, which was demonstrated in 1911. Experiments conducted indicate that the adults are able to attack either ground or tree inhabiting caterpillars.

FOOD CONSUMED BY ADULTS.

Daily feeding records were kept of four pairs of beetles received from Japan, July 22, 1910.

TABLE 27.—*Feeding records of four pairs of Calosoma chinense, 1910.*

Pair No.	Date received from Japan.	Ceased feeding.	Male died.	Female died.	Fourth to sixth stage caterpillars consumed.		
					Porthetria dispar.	*Estigmene acraea.*	Total.
4524	July 22	Sept. 8	Aug. 24	Sept. 9	55	138	193
4525	22	9	....	....	61	132	193
[3] 4526	22	9	....	....	50	92	142
4527	22	9	[4] July 30	....	33	125	158

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[1] Kirby, W. A century of insects. *In* Trans. Linn. Soc. London, v. 12, p. 375–482 (p. 379, no. 5), pl. 21–23, 1818.

[2] Dejean, le Comte. Species Général des Coléoptères, t. 5, 883 p. (p. 563). Paris, 1831.

[3] Female deposited eggs.

[4] Male added from same shipment to replace dead male.

All the caterpillars of *Porthetria dispar* eaten by the beetles were in the sixth stage, while the larvæ of *Estigmene acraea* ranged from the fourth to the sixth stage. An average of 172 large caterpillars were eaten by each pair from the late date the beetles were received to the end of the feeding season. The only pair of beetles that lived emerged from hibernation June 7, 1911, and immediately began to feed actively. From this date to July 22 the pair ate 63 sixth-stage caterpillars of *Malacosoma americana* and 57 fifth and sixth stage caterpillars of *P. dispar*, a total of 120. This number added to 172, the average number eaten by 4 pairs from July 22 to the end of the previous feeding season, equals 292, or approximately the number eaten by the Calosoma of equal size.

REPRODUCTION.

July 22, 1910, four pairs were placed in battery jars for rearing and feeding records. One pair was observed in copulation August 3 and from August 3 to 8, and later 54 eggs were deposited.

July 28, 1911, eight pairs of beetles just received were placed in large battery jars, as also one pair reared in 1910 from eggs deposited that year. The male of the latter pair died July 8, but another was added and the pair entered hibernation August 8 without having reproduced. Two females of the foregoing 8 pairs reproduced in 1911; one deposited 11 eggs and another 112 between August 7 and 17.

One of the eight pairs that entered hibernation in the fall without reproducing emerged May 13, 1912, and the female laid 217 fertile eggs from May 25 to July 1, and died July 10. This is the largest number of eggs deposited by a single female of this species in confinement.

The notes secured indicate that the species is fairly prolific under favorable conditions and, if it can be established, will undoubtedly prove very beneficial.

LONGEVITY OF ADULTS.

One female reared from the egg in 1910 was active during the season of 1911 and entered hibernation that fall. June 20, 1912, the cage was dug up but the female was dead in the earth, 3 inches below the surface. She died some time during the hibernation period and lived practically one year after issuance as an adult.

Many adults were received from Japan during the summer of 1911 and several of them successfully hibernated the following winter, and upon emergence were planted in colonies. The few that were left at the laboratory for rearing during the season of 1912 died toward the end of the summer before reentering hibernation. These adults lived two summers and one winter in confinement.

The data at hand show that the adults live at least two years, and it is very probable that three years is the usual limit as with some of the other species of the genus.

HIBERNATION OF ADULTS.

Three pairs of beetles received from Japan July 22, 1910, fed until September 10 of the same year and entered hibernation. As it happened, the beetles were collected and shipped at the time of their greatest activity, and as they were deprived of food en route for about three weeks, this probably had some influence on the date on which they entered hibernation. These beetles made cavities from 4 to 6 inches deep in loose soil, but all died before emerging the following spring.

One pair of adults reared in 1910 issued from pupæ September 13 and 18 and on September 26 were transferred to hibernation cages out of doors. June 7, 1911, the male emerged and the female was removed on that date. Both were in cavities 3 inches below the surface. The male died during the summer of 1911, but the female again entered hibernation August 12.

July 8, 1911, a large shipment of adults was received from Japan. Sixty-three males and 48 females out of the shipment were placed in a large outdoor hibernation cage and food was furnished them until they sought hibernation. Slightly less than one-third of these emerged successfully the following spring. In Massachusetts August 12 is the average date for entering and June 7 for emerging from hibernation.

There can now be no question that adults of this species can withstand New England winters.

COLONIES OF CALOSOMA CHINENSE LIBERATED IN 1911 AND 1912.

August 2, 1911, 60 females and 50 males, received from Japan July 28, were liberated in marsh land covered with weeds and grass along the Charles River in Cambridge, Mass. Larvæ of *Estigmene acraea* were so abundant in this area that 2,500 specimens had been collected for use at the laboratory just previous to the date (Aug. 2) on which the beetles were liberated. On August 4 Mr. W. L. Whithead visited the colony and saw four beetles, 2 of which were feeding upon caterpillars. This colony was visited by Mr. Dudley on May 7, 1912, and again on June 4. No insect life of any kind was found on the marsh on the former visit; on the latter date one male of *Calosoma chinese* was found a few feet from where the colony was originally planted. At the time of this visit there was no evidence of the feeding of caterpillars of *Estigmene acraea* on the weeds and grasses, and it is probable that the beetles were forced to migrate in search of food. No beetles have since been found in this colony.

At Stoneham, Mass., May 15, 1912, 15 males and 15 females, which were received from Japan in July, 1911, and which hibernated in a large outdoor cage in the laboratory yard during the following winter, were liberated in a market garden where cutworms were doing considerable damage. On June 4 the colony was visited by Mr. Dudley but no adults or larvæ were found. The cutworms at this time were not so numerous, but caterpillars of *Pontia rapae* and *Autographa brassicae* were present on the cabbage plants. No further evidence has been found that the species has become established.

Pelham, N. H., June 21, 1912, Mr. H. I. Winchester took 128 first, second, and third stage larvæ from the laboratory and liberated them in a woodlot badly infested with the gipsy moth. An examination was made in the fall of 1913 but no traces of the beetles were secured.

THE EGG.

Egg white, approaching a creamy shade, almost elliptical in form, slightly curved, usually a little larger at one end. Ten fresh eggs averaged 4.4 mm. in length and 2 mm. in width.

BRIEF DESCRIPTION OF LARVA.

First stage.—Small, rather stout. Average length of 10 specimens, 7.8 mm.; width, 2 mm. Caudal appendages 2.4 mm. long, straight, slender, bearing many long slender spines. Color blackish bronze above, ventral plates dark brown.

Second stage.—Stout. Average length of 10 specimens, 14.4 mm.; width, 3.3 mm. Caudal appendages long, rather erect, and curved upward beyond dorsal protuberance which arises less than one-half the distance between base and tip. Color slightly lighter than in first stage.

Third stage.—Robust in form. Average length of 10 specimens, 22.5 mm.; width, 4.3 mm. Caudal appendages similar to those in second stage, dorsal protuberance prominent, acute. Color bronze to blackish bronze, with pronounced metallic luster. No reddish-brown patch on dorsum of last segment in second and third stages.

LENGTH OF TIME REQUIRED TO COMPLETE THE LARVAL STAGES.

Observations were made on larvæ in 1911 to determine the length of time required to complete each stage. The records indicate that the first stage requires 4 days, the second 8, and the third 14; about 7 days additional are required in making cavities for pupation.

TABLE 28.—*Food eaten by larvæ of Calosoma chinense.*

No.	Date hatched.	Number *Estigmene acraea* caterpillars eaten, fourth to sixth stages.	Number *Hyphantria cunea* caterpillars eaten, fourth to sixth stages.	Number *Porthetria dispar* pupæ eaten.	Total.
	1910.				
4526-AC	Aug. 15	5	54	3	62
4526-AE	...do....	4	38	1	43
4526-AF	...do....	4	51	2	57
4526-AH	...do....	2	49	2	53
4526-AI	...do....	4	63	1	68
4526-AJ	...do....	4	37	3	44
4526-AK	...do....	4	53	1	58
4526-AL	...do....	4	45	2	51
4526-AM	...do....	4	67	2	73

All the larvæ cited in Table 28 died on becoming full-grown, except No. 4526–AK and No. 4526–AM, one of which escaped from the jar whereas the other pupated. The principal reason for the death of the larvæ was that the walls of their cavities for pupation collapsed.

The average number of caterpillars and pupæ required by each larva for food was 57. One caterpillar of *Estigmene acræa* or one pupa of *Porthetria dispar* is equal in sustenance to two or three caterpillars of *Hyphantria cunea*, and on that basis the average amount of food would be 25 to 30 medium-sized caterpillars. This number conforms very closely to the number consumed in 1911 when caterpillars of medium size were used.

HABITS OF LARVÆ.

Some experiments were conducted to ascertain whether these larvæ will climb trees to obtain food. (Pl. III.)

The experiment was started August 15, 1911, with two first-stage larvæ. They remained in the experiment two days, but did not attempt to climb. One larva was placed on the tree and climbed upward about 6 inches before falling.

August 18, 22 second-stage larvæ were left inside the tin circle. One larva was placed upon the bark and climbed slowly, then rested for a time in a crevice, later resuming its journey upward, and finally succeeded in reaching the cage at the top of the tree. This larva also climbed out 6 inches on a small twig. During the night of August 21 one of the larvæ climbed to the food cage on top of the tree, ate part of a gipsy-moth pupa, and descended to the base before 8 a. m., August 22. In this particular case it was impossible to determine whether a second or third stage larva had entered, as one specimen had transformed to the latter stage.

From August 22 to September 4, third-stage larvæ were placed in the circle about the tree. On the afternoon of August 24 one third-stage larva was found feeding in the food cage at the top. On August 30 two different third-stage larvæ were liberated in the circle and later one of these was placed upon the tree, on which it continued to climb at intervals until it reached the food cage. On September 1 one third-stage larva was found in the food cage. It had eaten one pupa of *Plusia brassicæ* and one caterpillar of *Hyphantria cunea.*

The larvæ of this species climb to some extent in all stages. The experiments indicate that the large larvæ climb the best.

PUPA.

The average length of the female pupa is 19.6 mm. and the width 8.1 mm.; the male pupa averages 17.5 mm. in length and 8 mm. in width.

Based on data secured from four specimens, an average of 13.5 days was passed in this stage.

CALOSOMA DISCORS Lec.

ORIGINAL DESCRIPTION.

Wingless, less elongate, black, thorax short, quite intricately rugose, with sides quite rounded, margin somewhat depressed, base emarginate, broader than long at middle, elytra oval, slightly broader than the thorax, densely substriate with striæ and interstices bearing a row of punctures, and with three rows of impressed indistinct dots.

Length 0.75 to 0.82. [Pl. I, fig. 9.]

LeConte [1] adds the following to this description:

San Fran. Mr. Child; Sacramento, Mr. J. Wittick. This species by its short, robust form, and by the absence of wings, simulates Callisthenes, but the antennæ are as in other species of Cal.

Body black, without metallic lustre. Head elongated, rough, with confluent wrinkles and punctures; antennæ with the third joint strongly compressed twice as long as the fourth, fifth and following joints entirely pubescent. Thorax more than twice as wide as the head, and fully twice as wide as its length, not convex, margined, with the sides somewhat depressed behind, but not reflexed; base transversely impressed, and faintly bifoveate; middle part truncate, posterior angles moderately produced, hardly acute at apex. Elytra oval, moderately convex, a little wider than the thorax, marked with faint approximate striæ, which are strongly punctured; the narrow interstices are also marked each with a row of punctures equal to those of the striæ; in certain lights three rows of very indistinct foveæ may be seen in the usual position.

This species has also been reported from Washington and many localities in California.

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[1] LeConte, J. L. Report upon insects collected on the Survey. (Reports of explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean. Made under the direction of the Secretary of War in 1853–1855. Supplement to v. 1. Zoological report no. 1.) 72 p., 2 pl. (p. 31, pl. 1, fig. 9). 1857.

CALOSOMA WILKESII Lec.

ORIGINAL DESCRIPTION.

Deep black, punctate, with thorax more than twice shorter than broad, narrowed posteriorly, sides quite rounded, margin somewhat reflexed, base broadly emarginate, posterior angles slightly produced, elytra nearly one-half longer than broad, not dilated posteriorly, rugose-punctate, with pits on both sides faintly marked in triple row. Length 0.65. Oregon. I have seen a specimen also in collection of the celebrated Exploring Expedition led by Charles Wilkes.

This species was described by LeConte[1] in 1851 and has since been reported as occurring in California, Idaho, Oregon, and Washington.

CALOSOMA LUXATUM Say.

ORIGINAL DESCRIPTION.

Brownish-black; elytra reticulate; head and thorax minutely punctured.

Inhabits Arkansas.

Mandibles flattened above, rugose, with oblique lines: head punctured: antennæ, second joint half as long as the third; thorax minutely punctured, punctures larger and confluent on the lateral margin; posterior angles rounded, extending backwards a little beyond the basal line; an impressed longitudinal line: elytra suborbicular, reticulate; longitudinal lines not more dilate or profoundly impressed than the transverse ones, which are not continuous, the points of intersection not distinguished by a puncture; the three punctured striæ obsolete, their traces hardly discernible in a certain light and not differently colored.

Length more than three-fifths of an inch.

This insect has the short, transverse thorax of Calosoma, but the proportions which the joints of the antennæ bear to each other are similar to those of many *Carabi;* the transverse lines are dislocated by the longitudinal ones.

Described by Thomas Say in 1823. Since that time several other species have been described which are generally considered as varieties of *luxatum.* Among these are *striatulum* Lec., *zimmermani* Lec., and *pimelioides* Walk. The former is undoubtedly a synonym of *luxatum* Say and the latter of *zimmermani* Lec. The writers have seen specimens of *Calosoma striatulum* Chev. from Arizona, which was described in 1835 by A. Chevrolat, habitat, Perote, Mexico.[2]

A few writers believe that some of those above-mentioned are distinct species[3] but the writers are unwilling to separate them in this way without having a large amount of material for comparison and study, and this is not available at present.

The bibliography is all listed under *C. luxatum* with a summary of the notes given on it and its varieties by various authors. It is the belief of the writers that a careful revision of this species and its so-called varieties should be made.

The writers feel, however, that a more complete series of specimens should be available for study before this is done, hence the whole is considered under *luxatum* and its varieties.

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[1] LeConte, J. L. Description of new species of Coleoptera from California. *In* Ann. Lyc. Nat. Hist. N. Y. f. 1851, v. 5, p. 125–216 (p. 200).

[2] The writers have received the loan of some material in this group from various entomologists of the United States, also have been in correspondence with Dr. E. C. Van Dyke, of the University of California, who has a large collection and who intends publishing later. The writers appreciate the need of detailed work in this group and give way to one who possesses the material for properly treating it.

[3] Col. Thos. L. Casey, in his "Memoirs on the Coleoptera IV" (Lancaster, Pennsylvania, 1913, p. 66–75), holds this view. He has subdivided the genus into Calosoma and Callisthenes, listing under the latter *luxatum* Say, *zimmermani* Lec., *striatulum* Lec., *pimelioides* Walk., *latipenne* Horn, and several new species and subspecies.

DISTRIBUTION.

Some of the museum and experiment-station collections of the United States contain numerous specimens of *C. luxatum* Say, *C. zimmermani* Lec., and *C. striatulum* Lec. Among the States and Territories where *C. luxatum* Say is reported as occurring are Arizona, California, Colorado, Indian Territory, Kansas, Montana, Nebraska, Nevada, Oregon, Utah, Washington, and Wyoming. Those for *C. zimmermani* Lec. are California, Kansas, Montana, Nebraska, Nevada, Oregon, Texas, Washington, Wyoming, and the Rocky Mountains without a State label. It is also reported from Canada. *C. striatulum* Lec. has been reported from Arizona, California, Colorado, Idaho, Kansas, Nebraska, Nevada, Utah, and Wyoming.

April 25, 1910, Mr. J. A. Hyslop of this bureau forwarded to the gipsy moth parasite laboratory several live beetles collected at Govan, Washington. One male and two females were placed in a jar of earth and fed larvæ of *Noctua clandestina* and *Malacosoma americana*. The females consumed 16 full-grown larvæ of the former and 3 of the latter species before May 24, when the last died. The male died in two days and did not feed.

BIBLIOGRAPHY.

1823. Say, Thomas. Descriptions of Coleopterous insects collected in the Expedition to the Rocky Mountains. Journ. Acad. Nat. Sci. Phila., T. III, 1823, p. 149–150.

Original description of *Calosoma luxatum*. Habitat, Arkansas.

1835. Chevrolat, A. Coléoptères du Mexique, Fasc. 7, p. 165..

Description of *Calosoma striatulum* from Perote, Mexico. This species has since been taken in Arizona, hence its inclusion here.

1848. LeConte, J. L. A descriptive Catalogue of the Geodephagous Coleoptera inhabiting the United States east of the Rocky Mountains. Ann. Lyc. Nat. Hist. N. Y., T. 4, 1848, p. 445.

Description of *Carabus zimmermani* from the Rocky Mountains.

1848. LeConte, J. L. A descriptive Catalogue of the Geodephagous Coleoptera inhabiting the United States east of the Rocky Mountains. Ann. Lyc. Nat. Hist. N. Y., T. 4, 1848, p. 445.

Short descriptive notes on *C. luxatum* giving its habitat as the River Platte.

1860. LeConte, J. L. The Coleoptera of Kansas and eastern New Mexico. Smithsonian Contributions to Knowledge, Vol. II, p. 4.

Original description of *Calosoma striatulum* from Milk River and Utah. The author draws very close comparisons with his new species to that of *C. luxatum* and *zimmermani*..

1866. Lord, J. K. Naturalist in Vanc. Island and British Columbia. Vol. II, 1866, p. 312.

Description of a new species (*Callisthenes pimelioides*) by Mr. Walker, but no locality given.

1881–84. Bates, H. W. Biologia Centrali-Americana (Col.) Vol. I, Pt. I, pp. 23, 262.

List of localities in Mexico where *C. striatulum* Chev. has been taken.

CALOSOMA LATIPENNE Horn.

ORIGINAL DESCRIPTION.

Allied to *luxatum* Say, but differs from all the races of that species in having a proportionately smaller head, broader thorax with more rounded sides and more broadly reflexed margin, apex less deeply emarginate, basal angles more broadly rounded; elytra more broadly oval, marginal groove deeper from the more strongly reflexed margin.

Color black and shining, head sculptured as in the smooth forms of *luxatum;* thorax moderately convex, disc smooth with the median line distinct with the sides coarsely punctured and wrinkled. Elytra broadly oval, smooth and shining, disc with approximate striae of very fine punctures, margin broad as compared with *luxatum* and equal in its entire length except at base, where it is narrower, rather densely muricately punctured and in well-preserved specimens of a greenish-bronze color. Under surface and legs black and shining almost entirely smooth and impunctured. Length 0.54–0.68 inch; 14–17 mm.

In most of the specimens before me the margins of the elytra immediately behind the humeri have three or four very distinct serrations. This character is quite common in the species of the *triste* group, but not seen in any of our species of the group *Callisthenes*.

On comparison the male of this species is found to be as broad as the female of *discors* Lec., the elytral margin broader and the surface sculpture of a different order.

Collected by Mr. Win. M. Gabb and myself in the elevated regions of the South Sierras of California.

Described by Horn [1] in 1870. The species has later been taken by various collectors in several localities in California and in Reno, Nev.

CALOSOMA AUROCINCTUM Chaud.

(Syn.: *C. splendidum* Perbosc.)

ORIGINAL DESCRIPTION.

[Translation.]

Length 11–13 lines. This species is very distinct from the true *C. splendidum* Mannerheim, species from Haiti, as I have been able to convince myself by the examination of many individuals of each of the two species. *Splendidum* is of a beautiful uniform coppery green, while *aurocinctum* is of a metallic green, approaching blue, with the margins of the thorax coppery and those of the elytra of a brilliant coppery red. Head less heavily punctate; longitudinal impressions of the face much more marked. Thorax proportionately broader and more strongly rounded on the sides. Elytra less elongate, broadening more posteriorly; striæ less heavily denticulate; intervals less convex. Legs blue; the antennæ, mouth parts, legs, and tarsi which are reddish in *splendidum*, have a much darker color in *aurocinctum*. The habitat of this species is Mexico. I believe that it has nothing in common with *wilcoxi* Lec.

GENERAL NOTES.

This species was described by M. de Chaudoir [2] in 1850. The author bases his description on many individuals of this species collected in Mexico and compares it with *splendidum* Mann. from Haiti. Bates, in 1884, in his Biologia Centrali-Americana, listed *splendidum* Perbosc. as a synonym of *aurocinctum* Chaud.

Some years ago Mr. C. H. T. Townsend collected a specimen of *aurocinctum* Chaud. in Brownsville, Tex., which is deposited in the United States National Museum. The fact that a specimen has been taken in the United States is the reason for its mention here.

CALOSOMA DIETZII Schaef.

ORIGINAL DESCRIPTION.

Form of discolor, deep black, the reflexed elytral margin, base and sides of prothorax with a bluish reflection. Head sparsely punctate and very feebly rugose, epistomal impressions deep, causing a light convexity of the front; labrum angularly emarginate, rugose and impressed; mandibles stout, faintly rugose; antennæ nearly as long as the head and thorax, the outer joints at sides glabrous at base. Prothorax not quite twice as wide as long, widest before the middle, sides arcuate anteriorly, becoming nearly straight posteriorly, hind angles broadly arcuate and produced posteriorly, base slightly arcuate-truncate, apex broadly emarginate, with a broad, flattened, impunctured bead; disk moderately convex, basal angles feebly impressed and slightly reflexed, surface very feebly rugose, finely and sparsely punctate, the punctures larger at sides, coarser and more confluent in the basal region, median line fine. Elytra oval, not quite one-half longer than wide, very little broader than the thorax in its widest part, sides slightly arcuate, margin evenly and narrowly reflexed and coarsely rugosely punctate with a few granules intermixed; disk convex, striæ composed of fine, feebly impressed punctures, punctation of intervals finer and sparser; surface smooth. Length 15–18 mm.; width 7–8.5 mm.

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[1] Horn, G. H. Contributions to the Coleopterology of the United States. *In* Trans. Amer. Ent. Soc., v. 3, p. 69–142, pl. 1 (p. 70), 1870.

[2] Chaudoir, Baron de. Memoire sur la famille des Carabiques. *In* Bul. Soc. Imp. Nat. Moscou, t. 23, p. 349–460 (p. 420), 1850.

Tulare Co., Calif. Two males and two females in coll. Dietz which were mixed with typical *latipennis*.

This is the species referred to as *latipennis* by Major Casey in the remarks following the description of his *arcuata*. The true *latipennis* has a narrower thorax, similar to *luxatum*, different form of elytra, the humeri serrate and the elytral margin more narrowly reflexed near base than at apex.

C. dietzii is best placed near *discors*, which it more resembles than *latipennis*.

This species was described by Charles Schaeffer [1] in 1904.

CALOSOMA MAXIMOWICZI Mor.

[Pl. VII, fig. 9.]

ORIGINAL DESCRIPTION.

Obscurely greenish-coppery above, prothorax greatly rounded on the sides, somewhat narrowed posteriorly, but not contracted, elytra punctate-striate, interstices imbricately-grooved transversely, little dots impressed in series on the fourth, eighth and twelfth.

Female 27 mm.

Collected by Maximowicz on the way between Skabi and Ssawara.

This species was described in 1863 by A. Morawitz.[2] In 1883 it was reported by Bates at "Foot of the Komauotake; taken in abundance by shaking young oak trees."

In December, 1909, a dead beetle of this species was received from Rev. H. Loomis, Yokohama, Japan, and during the following summer a pair of beetles were received from Dr. Kuwana, but both died without feeding.

CALOSOMA SPLENDIDUM Dej.

ORIGINAL DESCRIPTION.

[Translation.]

Greenish, shining; elytra crenate-striate, small punctures impressed in triple rows; margin, tibiæ and tarsi black.

Length, 11½ lines; breadth, 5½ lines.

It resembles in form *scrutator*, but it is smaller, and its color dorsally of a beautiful metallic green, very shining. The head is proportionately smaller than that of *scrutator;* it has two very marked longitudinal recesses, between the antennæ, and it is covered with small sunken dots scarcely marked and not close to each other. The labrum, the mandibles and the palpi are black. The antennæ are missing in the only female individual which I possess. The eyes are brownish and very protruding. The thorax is less broad and less transverse than that of *scrutator;* it is narrowed posteriorly and covered with irregular wrinkles scarcely distinct; the longitudinal line of the middle is very marked; the posterior transversal impression is heavily marked, and it has on each side of the base a very distinct rounded impression; the anterior margin is truncate; the anterior angles are rounded; the sides are margined and somewhat recurved; the posterior angles are very pointed, and the base is deeply sinuate. The elytra have almost the same form as those of *scrutator*, and are striate and punctate in almost the same manner. The underside of the body and the legs are of the same color as the dorsum. The legs are of a sort of brownish-black. The tarsi are black. The mesothoracic legs are slightly arched; the metathoracic are straight.

It has been sent to me by Count Mannerheim under the name that I have kept for it, as coming from San Domingo.

It should be placed after *scrutator*.

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[1] Schaeffer, C. New genera and species of Coleoptera. *In* Jour. N. Y. Ent. Soc., v. 12, no. 4, p. 197–236 (p. 197), 1904.

[2] Morawitz, A. Beitrag zur Kaferfauna der Insel Jesso, v. 1, p. 20, pl. 1, fig. 7, 1863.

This species, type specimens of which were forwarded to Dejean from San Domingo by Count Mannerheim, was described by the former in 1831.[1] Dejean in his description gave Mannerheim as the authority for his new species, and the name of the latter has been erroneously quoted by many authors since that time.

According to recent writings of Mr. Chas. Schaeffer[2] this species has made its appearance in the United States and the following notes concerning its occurrence are copied verbatim:

> Two of the interesting additions to the coleopterous fauna of the United States, of which short descriptions are given below, were collected in Chokoloskee, southwestern Florida, and kindly given me by Mr. George Frank; the third: which I owe to the liberality of Mr. G. W. J. Angell, was collected at Enterprise, Fla., by C. W. Brownell.

A correction was added by the same author in 1910[3] to the effect that he had "reported this species wrongly from Enterprise, Fla. It was taken, as Mr. Angell informs me, in moderate numbers at lights in Key West, Florida."

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[1] Dejean, le Comte. Species Général des Coléoptères, v. 5, 883 p. (p. 558-559), 1831.

[2] Schaeffer, C. Three Cuban Coleoptera new to the fauna of the United States. *In* Jour. N. Y. Ent. Soc., v. 17, p. 148-150, 1909.

[3] Schaeffer, C. Additions to the Carabidæ of North America with notes on species already known. *In* Sci. Bul. Brooklyn Inst. Arts and Sci., v. 1, no. 17, p. 391-405 (p. 391), 1910.

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